G. Vasetsky

LOMONOSOV'S PHILOSOPHY

Progress Publishers Moscow

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INTRODUCTION

Mikhail Vasilyevich Lomonosov, Russian scientist and thinker, occupies a leading place among the world's greatest men of science and art. His investigations and theoretical generalisations in various fields stand out as milestones in the development of scientific thinking.

The uncommon versatility of his genius mirrored all that the Russian people had achieved culturally by the middle of the 18th century. Historically, he is of great significance not only because he revealed the best features of his people but also because of the tremendous contribution he made to Russia's development. Although he came from the very midst of the working people, he was able to surmount the incredible difficulties which Russian reactionaries and foreign gentlemen of fortune put in his way, becoming one of the greatest scientists of his time. In so doing he helped to explode the reactionary theory that only people from the upper classes could promote science and culture, whereas the working people were doomed to ignorance and slavery.

The vehement controversy precipitated by Lomonosov's theoretical works continues to this day. The reactionary classes and their ideologists in the old Russia of the tsar and the landowners sought to bury Lomonosov's progressive ideas or adapt them in distorted form to their own interests.

Progressive people in tsarist Russia, particularly revolutionaries from the nobility and revolutionary democrats, though often outnumbered, bitterly opposed the reactionaries and strove to popularise and further develop Lomonosov's ideas.

Thanks to their efforts, the attempt to obliterate Lomonosov's ideas and traditions was almost completely foiled in Russia in the second half of the 18th and in the 19th century, but it must be admitted that the ideologists of the ruling classes managed to limit the propagation and development of Lomonosov's principal theories.

An all-round scientific study of Lomonosov's work was launched after the October Socialist Revolution and a very important stage in these investigations was the publication of a ten-volume edition of his *Complete Works* with extensive notes and commentaries.

Lomonosov's works are still being studied by specialists in many fields today. Academician S. Vavilov, a Soviet scientist and an authority on Lomonosov's theoretical heritage, wrote in 1950: "Lomonosov's stature as a creative thinker has been revealed with surprising fullness in Soviet years thanks to the intensive work done by Soviet scientists, historians and literary critics."* In the past decade the study of Lomonosov's works has made further progress.

Especially thorough has been research into his works on natural science and engineering. Suffice it to mention the interesting papers written on these themes by S. Vavilov, D. Gordeyev, B. Kedrov, P. Kudryavtsev, B. Kuznetsov, N. Figurovsky, B. Chenakal and others.

A detailed assessment of Lomonosov's place and role in the development of Russian historical science is given in the works of M. Belyavsky, B. Grekov, D. Gurvich, M. Tikhomirov and other Soviet historians.

His philological and artistic works have also been thoroughly studied. In this connection mention should be made of papers by B. Berkov, D. Blagoi and V. Vinogradov.

Lomonosov has greatly contributed to the development of advanced philosophical conceptions. Advocates of idealism and theology are even today trying to destroy the materialist essence of his world outlook and give it an entirely religious interpretation.

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* Introduction to A. Morozov's *Mikhail Vasilyevich Lomonosov* (Russ. ed.), Molodaya Gvardia Publishers, 1950, p. 6.

Soviet philosophers have shown that Lomonosov was one of the most outstanding proponents of materialism in the 18th century. They consider him to be the founder of the trend in Russian materialist philosophy which was indissolubly bound up with natural science. His brilliant attempt to formulate a unified materialist system of the nature of things was the first ever to be made in Russia. Soviet scientists have written many works treating of his philosophical concepts and principles. But not all aspects of his philosophy have been expounded with the fullness they deserve. His sociology, for example, has not been adequately studied. A more thorough investigation should be made of such philosophical problems as his concept of matter and its properties, the process of cognition, the elements of dialectics in his works. It is also to be regretted that his ethical views have not as yet been studied or scientifically appraised. And yet it was precisely these views that were most distorted by the apologists of idealism and religion.

The primary purpose of this book is to shed light on these problems and thus enlarge our understanding of the philosophy of this great Russian scientist.

Chapter I

RUSSIA IN THE FIRST HALF OF THE 18TH CENTURY

Lomonosov's philosophy took shape and developed in a quite definite historical situation. It was, in fact, a theoretical expression of some of the most important aspects of that situation. Hence it is necessary, first, to describe the conditions, the social and economic factors that in the long run determined the trend and substance of Lomonosov's activity, and secondly, to describe the ideas of his predecessors on which he drew. The materialist method of research into the history of science and culture is primarily a matter of discovering their sources in the life of society and showing, without distorting historical facts, the material conditions that made it imperative for scientists and philosophers to solve certain problems. Karl Marx wrote: "It is, in reality, much easier to discover by analysis the earthly core of the misty creations of religion, than, conversely, it is, to develop from the actual relations of life the corresponding celestialised forms of those relations. The latter method is the only materialistic, and therefore the only scientific one. The weak points in the abstract materialism of natural science, a materialism that excludes history and its process, are at once evident from the abstract and ideological conceptions of its spokesmen, whenever they venture beyond the bounds of their own speciality."*

If even fantastic religious conceptions that radically distort external reality can and should be attributed to the objective factors of social life which themselves engender these conceptions, it is all the more obvious that this method is applicable in describing the causes and peculiarities of scientific and cultural development.

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* K. Marx, *Capital*, Vol. 1, Moscow, 1965, pp. 372-73.

There are two groups of phenomena—material and spiritual—in social life. Historical materialism asserts that social being, whose principal content is material production, determines the consciousness and the spiritual life of the people.

Studying the relationship between the production of material and spiritual values, Marx emphasises that the bonds between them should be viewed not as an invariable category but from historical positions. Every social and economic formation produces its own spiritual values.

In the final analysis Lomonosov's social and political, scientific and philosophical concepts must be attributed to the actual social conditions in Russia in the first half and the middle of the 18th century. But it would be a mistake to seek their origin only in the socio-economic peculiarities of Russian life, in the struggle between the classes of Russian society, or in the development of Russian science and culture, for historical development in Russia at the time was not a local process but one that was closely linked with the development of other, particularly West-European, states. Lomonosov lived and matured as a scientist not only under the influence of concrete Russian reality but also to some extent under the influence of historical conditions in Germany, Poland, France, the Netherlands, Sweden and other countries. Lomonosov grew up in the north of Russia near Archangel, which ever since the 17th century had been conducting increasing trade with Britain, the Netherlands and other West-European countries. In Archangel he met foreign merchants who told him about these countries, and later spent over four years in Germany and other countries of the West. This left a definite imprint on all his work.

As a rule, people tackle problems for whose solution material prerequisites are either already in existence or are being created. Lomonosov was not an exception. Working on scientific or technical problems, he relied on the material prerequisites that existed in Russia and in some other countries at the time.

Lomonosov lived and worked in a period when commodity relations were developing in the depths of the serf system, a period when the Russia of the merchants and landowners was moving from strength to strength and the class contradictions between the landowners and the peasants were mounting. The growth of the productive forces, particularly in industry, stimulated the expansion of commercial ties both inside Russia and between Russia and other countries.

Lenin pointed out that in the 17th century the various regions, lands and principalities of Russia began gradually to merge into an integral whole. This process was engendered by the "increasing exchange among regions, the gradually growing circulation of commodities, and the concentration of the small local markets into a single all-Russian market. Since the leaders and the masters of this process were the merchant capitalists, the creation of these national ties was nothing else than a creation of bourgeois ties".*

The economic reforms enforced by the government of Peter I in the first half of the 18th century gave further impetus to this process. Significant, primarily qualitative changes took place in industry, agriculture and trade on the basis of the feudal mode of production. This qualitatively new factor was the appearance and development in the depths of a feudal society of the capitalist mode of production in the shape of manufactories employing a considerable number of hired workers.

Trade was also undergoing certain qualitative changes, testifying to the emergence and strengthening of capitalist relations.

The growth of merchant capital tends to stimulate production for the sake of exchange value and on an ever increasing scale turns products into commodities. In Russia merchant capital was steadily winning stronger positions and doing more and more to change the character of production, particularly in industry.

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* V. I. Lenin, *Collected Works*, Vol. 1, p. 155.

Agriculture underwent the least changes, due primarily to the fact that serf labour of the peasants using primitive implements could not ensure high rates of development for this key branch of Russia's economy. For centuries the peasants worked with the sickle and the wooden plough, and it was only in the middle of the 18th century that the scythe began to replace the sickle, to some extent raising the peasants' labour productivity.

In the first half of the 18th century new lands were being developed, primarily in the south and east of the country. The three-field system was widely practised, especially in the southern areas of the European part of Russia. The government of Peter I was taking steps to raise farm output, including animal products. The growth of commodity-monetary relations was acting as incentive for the landowners to increase the production of marketable grain and other agricultural produce.

The growth of towns and the increase in the army imposed new demands on the rural economy. To ensure the fulling mills with raw material the government forced the landowners to raise and breed sheep in areas where natural conditions were favourable for the purpose. In 1724 it ordered the construction of sheep-breeding farms in gubernias that had "air conducive to growing sheep and good wool".*

The expansion of foreign trade was an important factor promoting agricultural development, including livestock breeding. The following figures illustrate this point. In the three years between 1717 and 1719 Russia exported through St. Petersburg and Archangel 403,218 poods** of Russian leather and hides and 338,985 poods of beef fat.

The development of commodity-monetary relations and the expansion of trade intensified exploitation of serf labour in the countryside.

In the first half of the 18th century far-reaching changes were taking place in Russia's industry. Although large manufactories were growing fairly rapidly, they could satisfy only a fraction of the country's requirements. In those years, therefore, an important role was played by small groups of craftsmen and the domestic industry.

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* *Essays on the History of the U.S.S.R. The Period of Feudalism. Russia in the First Quarter of the 18th Century* (Russ. ed.), U.S.S.R. Academy of Sciences Publishing House, Moscow, 1954, pp. 59-60.

** One pood=16.38 kilos.

The government centered its attention on the construction of large metallurgical manufactories. Metallurgy was growing rapidly in the Urals, and by the thirties of the 18th century the Urals metallurgical area took the lead. The table below gives some figures on pig-iron output in 1724 and 1725.

	Pig iron (in poods)	
	1724	1725
Crown factories in the Urals and Siberia	212,440	206,882
Demidov's factories	247,717	369,220
Privately-owned factories in Central Russia	120,093	120,061
Total	580,250	696,163

If we add the pig iron smelted by some other factories, the total output for 1725 reached 800,000 poods.*

At the beginning of the 18th century Russia had 233 factories, by 1762 their number had increased to 984, and at the close of the century there were over 3,000. In this period the Urals developed into a major metallurgical area.

St. Petersburg, Moscow, Tula, Archangel, Ivanovo, Yaroslavl and many other towns were becoming key industrial and trading centres.

Other branches were also developing, primarily the factories catering for the army and the fleet.

By the end of 1725 the picture was as follows:**

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* *Essays on the History of the U.S.S.R.*, etc., p. 92.

** Ibid., p. 102.

Branches of industry	Number of factories		
	total	crown	private
Ferrous metallurgy and ordnance and small arms factories	40	22	18
Non-ferrous metallurgy	15	12	3
Dockyards	7	7	—
Fulleries	15	5	10
Sailcloth	9	4	5
Silk: fabrics	3	—	3
Ribbons and galloons	6	—	6
Paper manufactories	6	3	3
Tanneries	13	7	6
Glass-making	6	2	4
Gunpowder	13	8	5
Saw mills	23	7	16
Other factories	22	12	10
Total	178	89	89

The rate and the scale of development of the metallurgical industry is shown by data for the central metallurgical area, where 40 foundries were built between 1701 and 1750.*

The pig-iron output of private factories in the European part of Russia increased from 120,000 poods in 1720 to 300,777 poods in 1739; in this period they smelted a total of 4,290,543 poods of pig iron.**

In the Urals alone crown factories increased pig-iron output from 5,110 poods in 1720 to 335,507 poods in 1739. Their total output in these 19 years amounted to 4,983,270 poods.

The growth in the number of big factories led to the designing and installation, though at a slow rate, of more complex mechanisms. In the first half of the 18th century the Urals foundries were using more or less up-to-date machinery, and the average annual production of pig iron at crown factories was fairly high—515,000 poods in 1725.

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* N. Pavlenko, *Development of the Metallurgical Industry in Russia in the First Half of the 18th Century* (Russ. ed.), U.S.S.R. Academy of Sciences Publishing House, 1953, p. 67.

** Ibid., pp. 70-71.

Industrial development in Russia created new prerequisites for scientific and technical progress. This in turn led to the emergence of such outstanding Russian inventors as Y. Batishchev, A. Nartov and others, who by their own efforts designed improved types of industrial machinery and military equipment. Nartov went to West European countries for the express purpose of "studying lathes and other machines". During his stay in London in 1719 he wrote to Peter I: "I have not found lathe operators here who are better than Russian; I also showed them the drawings of the machines which your Royal Highness had ordered to be made here and they said they could not do so according to the drawings."*

In the middle and in the second half of the 18th century other brilliant Russian inventors came to the fore, among them I. Polzunov and I. Kulibin. The development of the metallurgical industry and machinery was closely bound up not only with the increasing demand for metal for economic needs and the expansion of foreign trade, but also with growing military requirements. This is borne out by Peter's instructions to Butenant dated January 5, 1702. "Without delay," he wrote, "cast 100 iron cannon of the best quality without any defects, and 1,000 twelve-pound cannon-balls for each, to be delivered from Olonets ... not later than March 1702."

Beginning with the nineties of the 17th century and throughout almost the entire first half of the 18th century Russia's ruling classes encouraged the development of the armed forces and military equipment for defence purposes and also with an eye to conquering new territories and peoples.

Manufactories were not purely capitalist enterprises. They were an original combination of feudal and capitalist production, their main productive force consisting largely of serfs and hired workers.

P. Lyashchenko, a Soviet expert on the history of Russia's economy, rightly concludes that in this period "there emerged an 'extensive' patrimonial and serf industry exploiting the labour of peasants from the communes and those on quit-rent who worked at landowners' factories and workshops. The same may be said of the crown factories, which also used the labour of peasants who were obliged to perform feudal service and, though less frequently, hired labour".*

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* V. Danilevsky, *Russian Machines* (Russ. ed.), Leningrad, 1948, p. 145.

The serfs made up the bulk of the manpower at the manufactories. Hired workers officially were not serfs, nevertheless, their position was that of semi-serfs. Here are a few figures.

According to the Manufactur-Collegia, in 1753 out of 158 factories under consideration 63 (that is 40 per cent) had mainly hired workers. In 1767, out of 45,500 workers at 496 factories under consideration 21,900 (48 per cent) were peasants who had either been assigned to a given factory or bought by it, 5,800 (12.7 per cent) were serfs and 17,800 (39.3 per cent) were hired workers.**

At the beginning of the sixties the industries controlled by the Manufactur-Collegia had 38,000 workers, of whom 12,500 were hired workers, 14,000 were peasants assigned to factories and 11,500 were serfs. The hired workers were virtually semi-serfs because they could not quit work without permission from the factory owners.

Trade was also growing relatively fast; Russia was expanding her internal and foreign trade with West-European countries, especially with Britain and the Netherlands.

In 1749, Russia exported 579,000 poods of iron, between 1758 and 1760 she exported 790,000 poods a year, and from 1778 to 1780, export was 1,968,000 poods a year.*** From 1725 to 1762 the value of her exports of grain, iron, holland, hemp and flax rose from 4,200,000 to 10,900,000 rubles. At the same time her imports, which primarily went to satisfy the needs of the nobility and merchants, increased from 2,100,000 to 8,400,000 rubles. The bulk of these imports consisted of smooth-textured cloth, silk fabrics, jewelry, sugar, wines, coffee, tea, etc. She also imported small quantities of industrial raw materials (cotton, silk, etc.).

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* P. Lyashchenko, *History of the Economy of the U.S.S.R.* (Russ. ed.), Vol. I, 1950, p. 316.

** D. Baburin, *Essays on the History of the Manufactur-Collegia* (Russ. ed.), Moscow, 1939.

*** S. Strumilin, *Ferrous Metallurgy in Russia and the U.S.S.R.* (Russ. ed.), U.S.S.R. Academy of Sciences Publishing House, 1935, p. 174.

Internal trade was also expanding. New trading centres appeared and the number of annual fairs increased largely as a result of the repeal of internal customs duties announced on April 1, 1754. Russia was building up her military strength and improving her skill in the arts of war. Her army was scoring brilliant victories, such as the defeat of the Swedes at Poltava in 1709 and the rout of the Prussian army of Friedrich II and the capture of Berlin in 1760.

Russia's increasing economic and military strength found its expression in a relatively rapid growth of her merchant and naval fleets. As a result of Peter's reforms she built a powerful navy, which smashed the Swedish fleet at Gangut in 1714. Measures were taken to build more ships at the shipyards in the North and to construct new ones on the shores of the Baltic Sea and elsewhere.

To promote shipbuilding in Archangel, Peter I, on December 28, 1714, ordered all fishermen and traders to build within two or three years new sea-going vessels of the Dutch type instead of their old two- and one-masters. As a result of the persistent demands of the government large dockyards were set up on the Northern Dvina and the White Sea, where new, bigger and more modern ships were built, such as the one built by Vasily Lomonosov, Mikhail's father.

The population was also rapidly expanding. From 13 million in 1724 it increased to 19 million in 1762, that is, by 46.4 per cent. The number of townsfolk rose from 328,000 in 1724 to 802,000 in 1782,* the measures launched by Peter to promote the growth of the population having been continued after his death because this was in the interests of Russia's rulers.

As a result of deep-going economic changes Russia consolidated her independence and became one of the most powerful states in the world.

The reforms carried out by Peter and his followers led to closer ties with Western Europe. To overcome Russia's economic and cultural backwardness, they made use of many of the achievements of the western countries in economic and state organisation, science and culture. True, all this was done in the interests of the exploiter classes and frequently by brutal methods. Lenin wrote that Peter hastened the copying of Western culture by barbarian Russia, not hesitating to use barbarous methods in fighting barbarism.*

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* P. Milyukov, *Essays on the History of Russian Culture* (Russ. ed.), Part I, St. Petersburg, 1898, pp. 24, 79.

Russia required skilled personnel to develop her industry, shipbuilding and trade. For this purpose young Russians, including Lomonosov, were sent to the Western countries, primarily Germany, to study their economics and various branches of knowledge, including mechanics. Upon returning they plunged into the work of solving their country's vital economic and cultural problems.

Certain changes were also taking place in the correlation of classes in Russian society. As regards the social and class substance of Peter's reforms, their purpose was to strengthen the rule of landowners, accelerate the formation and growth of the class of merchants and consolidate the centralised monarchist-landowner state by still more brutal exploitation and oppression of the serfs. To further its policy of strengthening the rule of landowners and feudal lords and the positions of the nobility and the clergy, the government promulgated a number of laws expanding the rights of landowners to land tenure, ownership of serfs, etc. In 1760, it issued an *ukase* allowing the landowners to send their serfs to settle in Siberia. In another *ukase* two years later, the government granted greater freedom to the nobility and further extended the rights of the landowners with regard to serfs. The government multiplied the power and the wealth of the landowners by also giving them crown lands with the peasants who lived on them. Under Peter the nobility received 175,000 crown peasants (men), and Catherine II during her reign gave the nobles more than 800,000 crown peasants and huge areas of land. Economically the domination of the nobility rested on feudal ownership of the means and instruments of production and manpower. At the beginning of the 18th century the secular nobility owned up to 400,000 peasant households, the feudal clergy had 127,000 households, and the tsar and courtiers—100,000 households. The nobility controlled the entire machinery of state and had complete command of the armed forces. In every way the government helped the nobility to obtain the education required for work in the administration, the army and the navy.

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* See V. I. Lenin, *Collected Works*, Vol. 27, p. 340.

At the close of the 17th and especially in the 18th century, a new exploiter class, the merchants, began to emerge and develop alongside the landowners, who formed the main exploiter class in Russia at that time.

Under the serf system prevailing in Russia in the first half of the 18th century the merchants occupied a secondary place as compared with the nobility. But their influence mounted in proportion to the rise of commodity-monetary relations and the growth of industry and trade. Although Russia was a monarchistic and landowner state, she had to turn in increasing measure to the merchants and their capital in order to promote her industry and trade, finance the building of her navy and so forth. In 1719, the Collegium for the Mining Industry issued instructions stating: "All people, whatever their rank or property status, are permitted at their will to prospect, smelt and dress metals in all lands, both their own, or those owned by others." Regulations issued in 1723 by the Manufactur-Collegium contained analogous clauses.*

Peter and those who continued his policy drew extensively on the assistance of the merchants in effecting industrial, trade, military and other reforms. Many merchants, including Shchegolin, Miklyayev and Isayev, and some artisans (the Demidovs, Batashev and others) subsequently became powerful industrialists.

The second major class in Russia in the first half of the 18th century were the peasants, who comprised the bulk of the population and were the country's principal productive force. The following figures illustrate the ratio of peasants to other sections of the population in Russia at that time. According to an investigation conducted in the 1720s, the total number of people paying poll-tax in Russia (excluding the Ukraine, Lifland, Estland, Siberia and the lands on the west bank of the Volga, whose population was not subject to the poll-tax) was 5,570,468 (men), of whom 5,401,042, or 96.9 per cent, were peasants, while only 169,426, or 3.1 per cent, were townsfolk.

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* N. Pavlenko, *Development of the Metallurgical Industry in Russia in the First Half of the 18th Century*, pp. 320-21.

Almost all the essential material values were created by the skilled hands of the oppressed serfs. The landowners, merchants and the government used the peasants' inventiveness, their mother wit and their vast labour experience accumulated over the centuries to build new factories, towns, luxurious mansions, shipyards, the merchant marine, the navy, etc. The peasants who had received military training were the chief instrument of Russia's victories on land and sea.

By their labour the peasants provided the funds required for government institutions and for promoting science and culture. At the same time they were mercilessly exploited and lived in extremely onerous conditions.

Tsarist policy, which was geared to the interests of the exploiter classes of landowners and merchants, increased the oppression of the serfs, making their life altogether unbearable. Under the existing legislation the landowners could sell their serfs, punish them, sentence them to hard labour, and so on. The conditions of the peasants mobilised into the army or the navy, where they were brutally maltreated by officers from the nobility, were just as difficult.

People working at metallurgical and ordnance manufactories, fulleries, holland factories, shipyards and other enterprises, and builders erecting towns and fortifications also lived in extremely difficult conditions. Taras Shevchenko, the great Ukrainian poet and revolutionary democrat, described the dreadful plight of the builders of St. Petersburg, the new capital of Russia. This growing exploitation by the landowners, merchants and the state intensified the class struggle between the landowners and the merchants on the one hand and the peasants on the other. The fleeing of peasants to Siberia or to the western regions of the country and even abroad was a form of this struggle. But its highest manifestation were the peasant rebellions. The 1705-06 revolt in Astrakhan embraced the *streltsi* (the standing army of the time), the working people and the runaway peasants. The 1708 rebellion headed by Kondraty Bulavin developed into a mass peasant movement in the south of Russia and almost 30,000 government troops under V. Dolgoruky were needed to put it down.

The anti-feudal peasant revolts were, as a rule, pro-tsarist in character. This is borne out by a letter to the population of Russia written by Ataman Bulavin of the Don Army summoning all townsfolk, villagers, all common people, to stand up for the Christian faith and the tsar, and to fight against all nobles, money-grubbers and foreigners who were tempting the people of Russia away from the true Christian faith and into accepting their faith.*

Peasant revolts continued almost incessantly throughout the 18th century. Besides the landowners' peasants, they involved peasants owned by monasteries and those who were assigned to factories, and also hired workers. The immature, spontaneous and historically limited nature of these peasant revolts gave birth to naïve, utopian sociological theories which did not and could not reveal the true causes giving rise to peasant movements, or indicate the way out of slavery for the serfs.

Lenin wrote that "the peasantry, striving towards new ways of life, had a very crude, patriarchal, semi-religious idea of what kind of life this should be, by what struggle could liberty be won, what leaders it could have in this struggle ... why the forcible overthrow of tsarist rule was needed in order to abolish landlordism. The whole past life of the peasantry had taught it to hate the landowner and the official, but it did not, and could not, teach it where to seek an answer to all these questions".**

Changes in the economy and in the correlation of classes likewise determined the transformations that took place in state and cultural relations in that period.

Lenin pointed out that the "Russian autocracy of the 17th century with its Boyar Council and boyar aristocracy bears no resemblance to the autocracy of the 18th century with its bureaucracy, its ranks and orders of society, and its occasional periods of 'enlightened absolutism'."* The development of industry and trade and the appearance of an all-Russia market, formed the basis for consolidating the centralised monarchistic state and promoting reforms which the government introduced in the interests of the exploiter classes. The expansion of Russia's economic ties with other countries, her active participation in international affairs and the numerous wars she fought also indicated the need to enforce corresponding reforms in state organisation.

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* *Bulavin's Mutiny (1707-08)* (Russ. ed.), Moscow, 1935, pp. 450-51.

** V. I. Lenin, *Collected Works*, Vol. 15, p. 207.

Science and culture also made substantial progress. The principal causes stimulating a whole series of reforms in education, the training of personnel, and so forth were to be found in the concrete historical situation, primarily in the economic changes in the country. The development of industry, farming and trade, modernisation of military weapons and equipment, considerable expansion of the army and navy, the investigation and the use of new regions, the prospecting and the extraction of minerals, etc., all this brought Russian scientists face to face with far more complex problems than those that had confronted them, say, in the 17th century, and made it imperative to establish secondary and higher schools and scientific institutions. Two new schools, of artillery and navigation, were opened in Moscow in 1701. The first was situated in the new ordnance works and the second was housed in the Sukharevskaya Tower. In 1707, a medical school was organised at a military hospital overlooking the Yauza. Engineers, sons of noblemen, were trained at the Engineering School and the Engineering Academy which were opened in Moscow in 1712 and 1719 respectively. A Naval Academy was established in St. Petersburg in 1715. At the same time what were called "figure schools" were set up in a number of towns. The earlier established Slavonic-Greek-Latin Academy in Moscow and the Theological Academy in Kiev modified their curricula and broadened their sphere of activity.

The establishment of the Academy of Sciences in St. Petersburg was a landmark in the development of Russian science and culture. Peter played a direct part in all arrangements for its opening. The inauguration ceremony of this biggest scientific centre of Russia was held on December 27, 1725, several months after his death.

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* V. I. Lenin, *Collected Works*, Vol. 15, p. 337.

In 1732, another military-type secular educational establishment, the Knights' Academy, later renamed the Noblemen's Land Corps, opened its doors in St. Petersburg. Among the graduates of this incubator of aristocratic culture were the well-known writers A. Sumarokov and M. Kheraskov.

Moscow University, which played an inestimable role in promoting cultural progress in Russia, was founded in 1755.

In putting through all these measures to stimulate education, Peter and those who followed in his footsteps made use of many of the scientific and cultural achievements of the western countries and their experience in organising educational and scientific institutions. In addition, more and more scientists, medical workers, teachers, builders, industrial specialists, shipbuilders and other experts from foreign countries were invited to work in Russia; Russia was becoming Europeanised.

Many aristocratic and later bourgeois historians exaggerated the influence of the West European countries on Russia's development, primarily because of the growing economic and other forms of dependence of large sections of her exploiter classes on these countries. Many theories were evolved that attempted to "prove" that the Russians were absolutely incapable of independent creative activity and that they could rely only on the achievements of other peoples. This reactionary trend in assessing the extent of Russia's so-called Europeanisation was openly expressed in I. Zamotin's article "Two Elements in Lomonosov's Literary and Public Activity", written on the occasion of the bicentennial of the great scientist's birth. The author, without any proof to offer, endeavoured to show that Russia's economic, scientific and cultural development had two beginnings, that it was engendered by two elements: the passive beginning—the Russian people, its scientists, writers, etc., and the active beginning—the economic, scientific and cultural influence of the Western countries. He claimed that it was the active beginning that produced conditions which led to the reforms enforced during the reign of Peter I. Zamotin applied this basically false and anti-scientific "theory" in analysing Lomonosov's creative genius, which he tried to present as a product of the influence of West European science and culture.

He summed up the opinions of many aristocratic and bourgeois investigators who had studied the history of Russia, including the history of her science and culture, and arrived at the following conclusion: "A ray of European enlightenment had penetrated into the depth of the mighty spiritual forces that were still in their embryonic stage, still slumbering and inactive under the dim northern sun, stirred them up and brought to life, in the person of M. V. Lomonosov, a new type of man with hitherto unknown social and psychological qualities. The natural treasure store of the Russian spirit and the refined frame of European culture in which it is set are the two basic elements of our progressive spiritual growth; they were the starting point for Lomonosov's mighty development and, in his person, for the development of Russian science, Russian literature and Russian society."*

So, according to Zamotin, it was not the preceding development of the Russian and other peoples of Russia, not the wealth of experience accumulated over the centuries, and not the values created by the working people in the economic and other spheres of activity, but a "ray of European enlightenment" that formed the basis for Russia's cultural and scientific progress in the 18th century, including the work of Lomonosov. Progressive Russian scientists and men of arts and letters, Lomonosov among them, waged a decisive struggle against this pernicious theory, which did Russia a great deal of harm.

With his usual perceptiveness Lenin wrote about Russia's Europeanisation: "Our liberals in general—and they are followed by the liberal labour politicians (liquidators) —like to talk about the 'Europeanisation' of Russia. A tiny little truth serves here as a cover up for a big untruth.

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* I. Zamotin, *Two Elements in Lomonosov's Literary and Public Activity* (Russ. ed.), Warsaw, 1911, p. 2.

"There can be no doubt that Russia, speaking generally, is becoming Europeanised, i.e., reorganised in the image of Europe.... But this Europeanisation has been going on since Alexander II, or perhaps even since Peter the Great; it went on not only during the upswing (1905), but also *during reaction* (1908-11); it has been going on in the police and among the Markov-type landlords, who are 'Europeanising' their methods of fighting the democratic movement.

"The catchword 'Europeanisation' turns out to be so general that it serves to obscure matters, to obscure urgent political issues."* Lenin's generalisation may well be applied with due consideration for the specific historical processes current in 18th-century Russia and for that particular "Europeanisation" of the country carried out by Peter I and his successors.

Russia's foremost statesmen, and Peter I, above all, borrowed much of the experience of economic and state organisation of the western countries. On the one hand, the positive sides of this experience stimulated Russia's progress. On the other hand, however, her exploiter classes adopted the new forms and methods of oppressing the working people that were employed by the western landowners and the bourgeoisie. It was only natural, therefore, that the growing ties between Russia and the western countries should be extremely contradictory in character. The advanced sections of the nobility and the merchants and their ideologists strove to use the achievements of the West to do away with Russia's technical, economic and cultural backwardness, while the ruling feudal aristocracy sought to use western methods to strengthen the moribund system, to intensify their oppression of the working people and to crush the insurgent peasantry.

Progressive West European scientists (Euler, Bernoulli and others) who worked in Russia, helped to raise her cultural level. There were several West-European scientists who were fruitfully working in Moscow University. At the same time, however, with the help of the ruling circles quite a number of foreigners, particularly Germans, wove a nest for themselves in the government apparatus and in military and scientific institutions, implanting traits and traditions that were alien to the Russian people.

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* V. I. Lenin, *Collected Works*, Vol. 18, p. 563.

A large group of Germans headed by Ernst Biron, for example, entrenched themselves at the court of Anna and advocated policies in Russia that were dictated by the ruling classes of Prussia and other foreign countries. Progressive Russian politicians and men of science and art, Lomonosov included, had to fight tooth and nail against these undesirable foreigners and their benefactors.

Among the Russian nobility and especially the courtiers kowtowing to the West, to the Germans in particular, assumed large proportions and ugly forms. German tsarinas, wrote Herzen, flung wide open the doors of Russia for their compatriots and a whole horde of people from the 26 German duchies descended on the banks of the Neva. Having no other wish than to preserve the good graces of the sovereign, they served the throne and not the people, displaying the utmost indifference to the lot of those over whom they lorded, infinite contempt for the Russian people and scorn for Russian culture and national traditions.

The Academy of Sciences and other scientific and educational institutions were dominated by foreigners. Dilthey, Rost, Reichel, Schaden and other foreigners at Moscow University were conducting a reactionary policy. Some far-sighted Russian aristocrats realised that all this impeded the rise of science and education in the country. N. Panin, leader of the noblemen's opposition, stressed that the Academy "has been deprived of all attention; that we have no junior schools for bringing up young men and preparing them for academic studies, that it is imperative to have such schools in order to spread education. And indeed of what use is it, and how can intelligent people think that the Mother country will benefit from the fact that 10 or 20 foreigners, summoned to Russia for a huge sum of money, will write in a language known by a very small number of people?"*

Lomonosov developed as a scientist and man of arts on Russian soil and his work was engendered by Russian reality. Contrary to the views of reactionary historians from the nobility and the bourgeoisie, who claimed that the Russian people were incapable of making an independent contribution to culture, Russia was making steady technical, scientific and cultural progress. When Lomonosov appeared on the scene, she had already accumulated quite a wealth of material and spiritual values.

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* *Semyon Poroshin's Notes* (Russ. ed.), St. Petersburg, 1844, pp. 40-41.

Eighteenth-century Russian technical science had such fine representatives as G. Skornyakov-Pisarev, Y. Batishchev, I. Pososhkov, A. Nartov, I. Kulibin, I. Polzunov and others, who had independently constructed complex machines, including military equipment. An indication of the high level Russian technical thought had attained by the beginning of the 18th century was G. Skornyakov-Pisarev's book *Static Science or Mechanics*, published in 1722. In it the author attempted to generalise the experience in creating and employing seven types of machines. "The most important machines," he wrote, "are divided into seven types. The first are fitted with a balancer. The second, with an upward-moving lever. The third, with wheels and an upright winch. The fourth, with cog-wheels and pinions. The fifth, with wedges. The sixth, with screws. The seventh, with discs."*

A. Nartov has many outstanding technical inventions, among them an intricate copying machine with a mechanical carriage, and machines for threading screws and making saws. He also designed a rapid-fire battery of 44 small mortars, and various devices for studying mechanical, physical, chemical and other natural phenomena.

Social thought in Russia in the first half of the 18th century made further headway thanks to the works of F. Prokopovich, A. Kantemir, V. Tatishchev and I. Pososhkov. These men of learning not only helped to enforce what are known as Peter's reforms, which boosted the development of economy and education in the country, but also made ingenious attempts to explain the nature of various social processes by means of theoretical analysis.

In the field of natural science, besides Leonhard Euler, Nicolas and Daniel Bernoulli, Georg Krafft and other eminent foreign scientists, who had lived and worked in Russia for many years and actively promoted her scientific development, a whole group of brilliant Russian scholars appeared, among them the ethnographer and Professor of botany S. Krasheninnikov who was the son of an ordinary soldier. Krasheninnikov, wrote one of his contemporaries, was one of those people who make a name in the world not through noble birth or mere good fortune, but through their own personal merits and work, taking nothing from their ancestors, and who are fully entitled to call themselves masters of their own destiny.

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* G. Skornyakov-Pisarev, *Static Science or Mechanics* (Russ. ed.), St. Petersburg, 1722, p. 3.

Considerable headway was also made by Russian letters. A. Kantemir, F. Prokopovich, V. Trediakovsky, A. Sumarokov and others charted new paths for Russian literature and the Russian literary language.

The development of art was furthered by such gifted Russian painters as I. Nikitin, A. Antropov and I. Argunov, and sculptors F. Shubin, Dudin and others. The permanent Russian Theatre for Staging Tragedies and Comedies was organised in 1756. A major role in promoting Russian theatrical art in this period was played by F. Volkov.

In his works and in practical activity Lomonosov, as a rule, expressed progressive trends in Russia's development. His scientific and social and political views were for the most part a theoretical generalisation and an expression of the social development that was taking place in the country. Some social processes in the western countries were also reflected in his works. The driving force behind Lomonosov's versatile activity was his patriotism, his love for the people, and a persistent desire to promote Russia's economic and cultural progress. He outlined as thoroughly as it was possible in those years the goals towards which the country had to move in her scientific and cultural development.

Lomonosov had many followers during his lifetime and after. A large number of his pupils worked at Moscow University, and his works were published and republished several times. Lomonosov's writings were a source of inspiration for many generations of progressive scientists and men of art. His full and active life is in itself instructive, providing, as it does, further insights into the essence of his works and his motives in dealing with this or that problem.

Lomonosov spent the first 19 years of his life in Pomorye (the White Sea coast area) which in the 17th and the beginning of the 18th century was an important centre of trade between Russia and Western Europe. Its biggest port, Archangel, handled trade with England, the Netherlands and other countries. For various reasons the level of economic and cultural development of this region was relatively higher than in other parts of Russia. Archangel and Kholmogory had shipbuilding yards, while smithies and other small manufactories turned out industrial commodities. The position of the peasants was somewhat different than elsewhere in Russia, since they were much less dependent on serf-owning landlords.

As Plekhanov correctly pointed out, the peasants of this region had for centuries lived not quite as peasants did in other parts of Russia. "It cannot be said", he continued, "that there was no large-scale ownership of land here; there were many *monasteries* in the North which owned land and used the labour of their peasants. But this was only half the trouble, and the other, and worse, half did not exist; there were no *landed estates* here. This circumstance could not but favourably influence the character and habits of the local population, which, moreover, from the days of the free city of Veliky Novgorod still led a very mobile life and were more independent than the inhabitants of the Moscow heartland. This independence of character was accompanied by a higher level of culture".[*]

One of the first biographies of Lomonosov written by M. Veryovkin and published in 1784 says that Vasily, Mikhail Lomonosov's father, was a fisherman who was the first in the territory to build and rig a galliot in the European manner. This he did on the Dvina River, which flowed near his village. In this galliot, which he called the *Seagull*, he plied the river, the White Sea and the Arctic Ocean, catching fish, transporting various supplies and carrying officials and private individuals from Archangel to Pustozyorsk, the Solovetsky Monastery, Kola, Kildin, the shores of Laplandia, Semoyad and the River Mezen."*

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[*] G. Plekhanov, *Collected Works* (Russ. ed.), State Publishing House, Moscow-Leningrad, 1925, p. 140.

Lomonosov started working when still a child. For several years he accompanied his father on fishing voyages and helped him in his trading operations. The rugged conditions of life in the North fostered in Lomonosov strength of character, endurance and determination. The people of Pomorye led a varied life, which had the effect of stimulating the boy's mental faculties. It was this period that did much to mould his outlook on life. He saw his homeland and how the merchants, clergy, fishermen, artisans and peasants lived there. He studied the natural life of the North, with its rigorous climate and unique beauty. He talked to foreigners. In later years he frequently recalled this period which left an indelible imprint on his mind and became a source for some of his future scientific generalisations.

Lomonosov learned to read when he was 10, and at 14 he was the best reader in his parish church.

I. Lepyokhin, a Russian traveller, quoting reminiscences of people who knew young Lomonosov, wrote that already at the age of 12 "he liked to read psalms, canons and the lives of the saints, the latter according to local custom, from church books, displaying great ability and an excellent memory".**

Secular books such as *A Slavonic Grammar* by M. Smotritsky and L. Magnitsky's *Arithmetic* played an important role in awakening Lomonosov's interest in science: "His first acquaintance with secular books took place in the home of Khristofor Dudin," writes M. Veryovkin. "They were an ancient Slavonic grammar and a manual of arithmetic for student navigators printed in St. Petersburg during the reign of Peter the Great. The elder Dudin turned a deaf ear to his incessant pleas to let him have these books for a few days, but in his thirst for knowledge the lad for a long time did all he could to please the old man's three sons and eventually induced them to lend him these books. From that day he never parted with them, always carried them about with him and read them until he had learned them by heart."[*] In his later years Lomonosov himself called these books the gates to his erudition.

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* *Lomonosov*. Collection of Articles and Documents (Russ. ed.), Vol. II, U.S.S.R. Academy of Sciences Publishing House, Moscow, 1946, p. 56.

** B. Menshutkin, *Life Story of Mikhail Vasilyevich Lomonosov* (Russ. ed.), U.S.S.R. Academy of Sciences Publishing House, Moscow, 1937, p. 18.

He was particularly influenced by Magnitsky's *Arithmetic* which first revealed to his probing mind the wonderful horizons of science.

D. Galanin, who made a thorough study of this interesting book, wrote: "Magnitsky did not write a textbook, but a book for reading; such a book could not deal with mathematics alone, it had to be a philosophical work which, by studying numbers, studies the properties of things, unveils the secrets of the universe, the secrets which can be fathomed by studying the sky. Thus, in the main this book treats of the movement of heavenly bodies, the laws governing the changes in the Earth's surface, the conditions and elements of social life; the rest provides the preparation needed for comprehending its chief sections. The last of these sections is astronomy, which, at the same time, is the most important branch of the philosophy of natural science."[**]

Magnitsky's *Arithmetic* was a sort of a digest of information about nature, and the mathematics of those days. Magnitsky also examined a number of problems dealing with the structure of the universe. In this connection Galanin quotes the following passage from the book: "...should we omit an account of the system of the universe, everything that follows will be neither clear nor useful. Therefore this should not be done. As regards the appearance and shape of the Earth, we shall quote what we have learned from ancient and modern philosophers and on which they fully agree, but particularly we shall refer the reader to the Holy Scriptures. Philosophers unanimously agree that the world is shaped like a sphere and occupies a globular position and this is borne out by numerous facts."[*]

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[*] *Lomonosov*. Collection of Articles and Documents (Russ. ed.), Vol. II, p. 56.

[**] D. Galanin, *Leonty Filippovich Magnitsky and His Arithmetic* (Russ. ed.), Parts II and III, Moscow, 1914, p. 181.

Magnitsky expounds the views of Aristotle and other thinkers about the structure of the Earth and treats this problem in conformity with accepted scientific concepts that do not implacably clash with religion. "Similarly it is proved," he writes, "that the Earth is spherical and is divided into numerous parts, and we shall discuss this in greater detail in its proper place. The sense of sight, particularly when at sea, proves that the sky and the Earth are round-shaped. Therefore, people who know this never err in navigation and no one doubts this. Men hold different opinions about the position which the Earth occupies in space. But their disagreement on this issue is irrelevant insofar as we shall not treat of it and only consider the fact that the Earth and the sky are round-shaped, that the Sun, the Moon and other celestial bodies move in a circle, and that the orbit of each planet is divided into parts."[**]

Magnitsky was fairly well educated for those years; he had studied many Greek, German, Italian and other West European scientists.

Before his departure for Moscow Lomonosov already had a certain knowledge of natural science, mathematics and the Russian language. But there were no educational institutions in the North where he could continue his studies. He was frequently advised that he could obtain an education only in Moscow, St. Petersburg or Kiev. One of his first teachers, the man who taught him to read and write, used to say that to acquire great knowledge and learning a man must know Latin. "And this language can be learnt," he told Lomonosov, "only in Moscow, Kiev or St. Petersburg. Only in these cities are there enough Latin books."[***]

Permanent trading connections were maintained between the Pomorye and Moscow, particularly during the winter months.

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[*] D. Galanin, *Leonty Filippovich Magnitsky and His Arithmetic*, Part I, Moscow, 1914, p. 51.

[**] Ibid., pp. 53-54.

[***] *Lomonosov.* Collection of Articles and Documents, Vol. II, pp. 56-57.

Lomonosov learned all about Moscow and its educational institutions from the merchants and his decision to study in that city was not accidental. He was helped in his plans by local merchants, who were experiencing an acute shortage of literate people to assist them in transacting business.

And so, in 1730 Lomonosov, then a youth of 19, left for Moscow.

In Moscow he was beset by difficulties and privations. But he was too gifted and too eager to learn to be discouraged. He studied with great diligence at the Slavonic-Greek-Latin Academy and even made a trip to the Theological Academy in Kiev. There, according to M. Veryovkin, Lomonosov against his expectations discovered the same scholastic controversy around Aristotle's philosophy that was being waged at the Theological Academy in Moscow. Physics, mathematics and other natural sciences were very poorly taught.

"When the Zakonospassky Library failed to satisfy his thirst for learning", wrote Veryovkin, "he approached the archimandrite with request to be sent to the Theological Academy in Kiev for a year to study philosophy, physics and mathematics; but, contrary to his expectations in Kiev, too, he heard only empty verbal disputes concerning Aristotle's philosophy. Unable to make any headway in physics and mathematics, he stayed in Kiev for less than a year. spending most of his time reading ancient chronicles and other books in Slavonic, Greek and Latin."*

He returned to Moscow and went on studying assiduously at the Slavonic-Greek-Latin Academy, thus acquiring sufficient knowledge for independent work on which he subsequently embarked.

In 1736, after graduating from the Academy, he and a group of gifted students were sent to study at the St. Petersburg Academy of Sciences. There, in more favourable conditions, his singular talents rapidly developed.

Throughout his stay in Moscow, Kiev and St. Petersburg, Lomonosov not only persistently studied natural science, philology, history and all the other subjects on the curricula; he also took a keen interest in the life of these great cities. Even in these years he began to experience a clearly-defined dislike for religious scholastic philosophy. He carefully observed the life around him, the development of industry, trade and education in Russia devoting particular attention to studying those branches of science which were of practical importance.

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* *Lomonosov.* Collection of Articles and Documents, Vol. II, p. 58.

Peter the Great, himself an educated man, carried out extensive measures to promote science and education in the country and to prepare local-born specialists. He boldly cast aside old traditions in this field and judged people as much by their personal qualities as by the estate to which they belonged. The historian Vasily Klyuchevsky writes: "Peter recruited the people he needed regardless of rank or social status, and they came to him from all parts of the world and from all estates: Divner, the Chief of Police of the new capital, had been a cabin-boy on a Portugese ship; Yaguzhinsky, the First Procurator-General of the Senate, it was said, had been a swineherd in Lithuania; Vice-Chancellor Sharifov had been a shopman; Kurbatov, Vice-Governor of Archangel and inventor of stampted paper had been a manor serf; Osterman was the son of a Westphalian pastor; all these people, including Count Menshikov who, according to rumour, had once sold pies in Moscow's streets, met in Peter's company with the remnants of Russia's boyar nobility."*

Already during Peter's lifetime there were people who had risen from the lower social estates, acquired an education and vigorously participated in Russia's scientific and cultural development. Lomonosov, who was a son of a fisherman also became a scientist and man of art in the Russia of the 18th century.

Lomonosov's ideas were considerably influenced by F. Prokopovich, V. Tatishchev, A. Kantemir, I. Pososhkov and other gifted Russian scientists and men of letters who lived in the period of Peter's reforms. Lomonosov was well acquainted with the works of Tatishchev and even wrote a dedication to the first volume of Tatishchev's *History of Russia*. As regards the writings of Prokopovich and Kantemir, he read them during his studies at the Slavonic-Greek-Latin Academy in Moscow and the Kiev Theological Academy.

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* V. Klyuchevsky, *Essays and Speeches* (Russ. ed.), Moscow, 1913, p. 478.

Lomonosov had to display great firmness and pertinacity to surmount all the numerous difficulties arising from the desire of the ruling nobility to achieve its own selfish class goals in education.

Characterising the class nature of the tsarist government's policy in the field of education, G. Plekhanov wrote: "The circumstance that Russia was an autocratic state ruled by the nobility determined, among other things, both the course of education in the country, and the extent to which it was available to each social class. The 'nobility', particularly those who 'crowded around the throne' could satisfy its need for education, once this need arose, with relative ease. In 18th-century Russia it was obligatory for the nobility to study and those who did not fulfil their duty in this respect were held to account. On the other hand, the tax-paying section of the population had to provide the means for educating the nobility, while themselves remaining as ignorant as they were before the introduction of Peter's reform. True enough, the government was forced to open the schools to others besides the sons of noblemen because there were not enough educated 'gentry' to meet the numerous requirements of the state. But even in school, commoners did not mix with the nobility. When Moscow University was founded, two Gymnasiums for preparing university students were set up, *one for the nobility, the other for the commoners*. In St. Petersburg, where only the Academy of Sciences had a Gymnasium, the 1750 regulations prescribed that 'children of noblemen or of high-ranking officials are to sit at a special table, while children of commoners are to sit apart from them'. It would seem that the nobility valued these distinctions. We know what pains the enlightened Tatishchev took to see that in the sphere of education the nobility should be separated from the vile.

"Finally, it should be borne in mind that among those who were lucky enough, in spite of extreme difficulties, to enter a secondary or higher school, there were *no children of the numerous serfs*."*

Russia's economic and industrial growth, particularly her progress in constructing large manufactories, and the expansion of trade, called for increasing numbers of Russian and foreign scientists, mechanics and especially mining experts. This largely explains why in 1736 Lomonosov was sent abroad to study mining and natural sciences. Reiser, Councillor for Mining, whose son went abroad together with Lomonosov and Vinogradov, wrote a letter containing instructions on the future duties of the three men. "I strongly support the idea of sending young men first to Marburg. Insofar as they are to become learned chemists and metallurgists and not ordinary assayers or miners, it is essential that at the beginning they should acquire a certain knowledge of philosophy, mathematics and philology.... Moreover, Marburg is a place which has become famous through Wolff, and there is absolutely no doubt that on his instructions there are in the town, in addition to long-settled emigrants, also people well-versed in all useful sciences."**

At Marburg University Lomonosov studied under the prominent German scientist and philosopher Christian von Wolff, who greatly assisted the young man in acquiring a thorough knowledge of the natural sciences. Of all the subjects which Wolff taught the Russian students Lomonosov liked physics best. In his character-report of Lomonosov, Wolff wrote: "Mikhail Lomonosov, a young man of great ability, has, since his arrival in Marburg, regularly attended my lectures in mathematics, philosophy, and especially in physics. He is very eager to acquire a thorough knowledge, and I have no doubt that in due course, if he continues to apply the same devotion to his studies, he will be able, on his return to his own country, to work for her benefit. as I sincerely hope he will."***

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[*] G. Plekhanov, *Collected Works* (Russ. ed.), Vol. XXI, State Publishing House, Moscow-Leningrad, pp. 137-38.

[**] *History of Russian Literature* (Russ. ed.), U.S.S.R. Academy of Sciences Publishing House, Vol. III, Moscow, 1941, pp. 274-75.

[***] Quoted from B. Menshutkin's *Life Story of Mikhail Vasilyevich Lomonosov* (Russ. ed.), pp. 45-46.

At the same time Lomonosov was conducting independent scientific studies. While at Marburg University he carried out a series of investigations and wrote papers on problems of physics and philosophy in which he developed a philosophical conception of his own, which differed from the philosophical teachings of Leibniz and Wolff. Of special interest in this connection is his *Physical Thesis on the Distinction of Compound Substances Consisting in the Cohesion or Corpuscles. Written as an Exercise by Mikhail Lomonosov, Student of Mathematics and Philosophy, in the Month of March, 1739.* Already then Lomonosov firmly resisted all attempts to impose on him alien idealistic concepts, and Wolff failed to win his pupil's support for his idealistic philosophical views. Wolff himself wrote a letter admitting this fact.

At Marburg University Lomonosov studied the works of the great West-European philosophers, beginning with those of ancient Greece. Besides physics, he devoted a great deal of time to chemistry. He was particularly impressed with the works of the English chemist and natural philosopher Robert Boyle, and it was the latter's studies on the nature of minute particles of matter that prompted Lomonosov to elaborate this important problem.

Eighteen years later Lomonosov gave the following appraisal of Boyle's investigations: "After what I had read in Boyle, I set my heart on studying the minute particles of bodies. I kept thinking about them for 18 years; *I am not in the habit of beginning to think about a thing only when the time has come for it to be explained*" (Italics by the author—*Ed.*).*

In 1738-39, Lomonosov wrote two papers generalising for the first time his views on the structure of matter from the standpoint of his concept of natural science and philosophy; they were *Specimen of My Knowledge of Physics: on the Conversion of Solid Bodies into Liquids, Depending on the Movement of the Liquid Present*, and *Physical Thesis on the Distinction of Compound Substances Consisting in the Cohesion of Corpuscles. Written as an Exercise by Mikhail Lomonosov, Student of Mathematics and Philosophy, in the Month of March, 1739.*

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* Ibid., pp. 36-37.

Already in these works Lomonosov discusses some general problems of what was known as natural philosophy. The second work is particularly important, for it discloses Lomonosov's philosophical views as a young man. In it Lomonosov describes his understanding of the minute particles which make up all substances. He views these particles, or corpuscles, from a materialistic standpoint, whereas Wolff's lectures and the books recommended to him treated of nature from an idealistic point of view. Approximately at the end of 1740, Lomonosov wrote *Elements of Mathematical Chemistry*, in which he further developed his materialistic understanding of the particles. At the end of the book he lists some problems of natural philosophy:

"*General Section.* On what Exists and Takes Place in a Compound Substance.

"Book One. On What Exists.

1. "Fundamental Propositions.
2. "On the Nature of the Components of a Compound Substance.
3. "On Weight.
4. "On Cohesion.
5. "On Colour.
6. "On Heat and Fire.
7. "On Elasticity.
8. "On Sound.
9. "On Taste and Odour.

"Book Two. On What Takes Place.

"*Special Section.* On a Compound Substance in Particular.

"Book 1. Fundamental Propositions.
"Book 2. On Water.
"Book 3. On Earth.
"Book 4. On Universal Acid.
"Book 5. On Phlogiston, on Poison.

"The second section also deals with the weight of substances, and their mass and cohesion."*

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* M. V. Lomonosov, *Complete Works* (Russ. ed.), Vol. 1, U.S.S.R. Academy of Sciences Publishing House, Moscow-Leningrad, 1950, p. 83.

Thus, during his stay in Germany Lomonosov grew up into a prominent and entirely independent scientist and thinker of the materialist type.

After leaving Marburg, Lomonosov studied in Freiberg under Johann Henckel. But this stay in that town was brief, for the German chemist and metallurgist could teach him nothing new. Moreover, Henckel not only adhered to old concepts himself, but endeavoured to foist them on his pupil. "At that time," wrote Academician V. Vernadsky, "Henckel was already an old man and had long passed his prime as a scientist.... Henckel was a chemist of the old type without a trace of original thought, although he had made some certain correct observations based on his practical experience as an assayer and metallurgist.... He expounded his discoveries in a manner and form that concealed their true essence. A huge mass of observations, experimental knowledge of certain practical problems combined with the superstition of an artisan-scientist, and a complete lack of understanding of anything new or anything that rose above the ordinary—these were the typical features of his research."*

Lomonosov wrote: "Upon arriving in Freiberg I eagerly and diligently studied mining, metallurgy and chemistry." But when it came to theoretical chemistry Henckel could teach him nothing new, for even "most of Henckel's experiments failed because of his own clumsiness. Our diaries are filled with descriptions (which he dictated with an admixture of vulgar jokes and empty prattle) of such unhappy incidents. At the same time he despised all rational philosophy and once when at his request I began explaining the causes of chemical phenomena, he ordered me to stop immediately because I was not following his Peripatetic precepts but had based my explanation on the principles of mechanics and hydrostatics, and with his usual presumptuousness he began to make fun of what I had said, calling it mere fantasy."**

Lomonosov and Henckel fell out on scientific grounds. The former was already imbued with the spirit of advanced science, whereas his teacher adhered for the most part to outdated principles.

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* *Lomonosovsky Sbornik*, St. Petersburg, 1911, pp. 8-9.

** M. V. Lomonosov, *Complete Works*, Vol. 10, pp. 428-29.

It was for this reason that Lomonosov considered it useless to continue his studies under Henckel, and especially to attend his lectures on theoretical chemistry. He complained: "... in Freiberg I had nothing to eat, and nothing more learn, because I had mastered chemical analysis and had also completed the course in chemistry...."*

In Freiberg, however, Lomonosov gained a fairly thorough knowledge of mining and metallurgy, so much so that he wrote and published a research work *On Metallurgy or Mining*. He learned a great deal from Henckel, who was an authority in these fields. He also gained much by closely familiarising himself with methods of extracting minerals and smelting metals. Lomonosov frequently quoted from the material he had accumulated in the process of studying mining and metallurgy. His paper *On the Free Movement of Air Observed in Mines* is an interesting theoretical generalisation based on an investigation of mines in Freiberg. "When I was studying chemistry and mining in Saxony at the Freiberg factories," he wrote, "I observed time and again during my investigations of mines the movement of air which flowed through the pits and adits without induction by air machines and snuffed out miners' lamps and candles even in the calmest weather. I did not investigate the causes of this phenomenon at the time because my attention was almost wholly concentrated on the practical work which was going on all around me."**

Lomonosov left Freiberg and travelled via Leipzig to Marburg. Before setting out for Russia, he visited several towns in Germany and the Netherlands, thus obtaining a direct knowledge of the economic and socio-political conditions and the level of science and culture in these countries.

On January 5, 1740, Lomonosov wrote to Johann Schumacher informing him of his departure for Frankfort from Marburg, and from there by water to Rotterdam and The Hague. "The Count (Count Golovkin, then Russian Ambassador to the Netherlands—*G.V.*)," he wrote, "flatly refused to help me or to concern himself with the matter in any way. After that I left for Amsterdam, where I found some merchants I had previously met in Archangel. They strongly advised me not to return to St. Petersburg without official permission, and described the dire perils and misfortunes awaiting me should I venture on this step. This forced me to return to Germany. It is frightening even to recall the dangers and privations that dogged me on my journey. But it is a long story and for brevity's sake I shall refrain from describing them altogether. At present I am staying incognito with friends in Marburg and perfecting my knowledge of algebra, which I intend to apply to chemistry and theoretical physics. In the meantime I am consoling myself with the thought that I have been to the aforesaid famous cities, spoken to some skilful chemists, seen their laboratories and had a look at the mines in Hessen and Siegen."*

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* M. V. Lomonosov, *Complete Works*, Vol. 10, pp. 429-30.

** Ibid., Vol. 5, p. 531.

During his travels Lomonosov became acquainted with advanced trends in natural sciences and philosophy.

He returned to St. Petersburg in 1741, and henceforth worked hard and fruitfully for the benefit of his country. Coming, as he did, from the midst of the people, Lomonosov worked hard all his life. He waged a systematic and sharp struggle for the independent development of Russian science, for the eradication of Russia's economic and cultural backwardness and for the participation of the masses in cultural and scientific development.

Characteristic of Lomonosov's activity was the resolute and consistent way he worked to introduce and popularise new scientific problems both at the Academy and elsewhere.

Lomonosov was the most gifted scientist at the St. Petersburg Academy at that time. Yet it took him about four years to gain recognition in the scientific world. He was not appointed professor of chemistry until 1745.

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* Ibid., Vol. 10, p. 430.

Chapter II

LOMONOSOV'S SOCIOLOGY

Lomonosov was one of those genuinely progressive scientists who were courageously and persistently blazing new paths in various branches of science and culture, surmounting incredible difficulties and sweeping away the old, obsolete and bigoted concepts. Friedrich Engels, characterising the great figures of the Renaissance in Western Europe, wrote: "It was the greatest progressive revolution that mankind had so far experienced, a time which called for giants and produced giants—giants in power of thought, passion and character, in universality and learning. The men who founded the modern rule of the bourgeoisie had anything but bourgeois limitations. On the contrary, the adventurous character of the time inspired them to a greater or lesser degree. There was hardly any man of importance then living who had not travelled extensively, who did not speak four or five languages, who did not shine in a number of fields. Leonardo da Vinci was not only a great painter but also a great mathematician, mechanician and engineer, to whom the most diverse branches of physics are indebted for important discoveries. Albrecht Dürer was painter, engraver, sculptor and architect, and in addition invented a system of fortification embodying many of the ideas that much later were again taken up by Montalembert and the modern German science of fortification. Machiavelli was statesman, historian, poet, and at the same time the first notable military author of modern times."*

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* F. Engels, *Dialectics of Nature*, Moscow, 1966, p. 21.

Russia, though lagging behind many countries in development, was gradually entering the new age. The Russian people needed giants in thought and labour to be able to accomplish the new historical tasks that lay before them, and the new age produced a great statesman and public leader in the shape of Peter the Great.

Lomonosov was a similar figure in the field of science and culture. His work covered almost all aspects of 18th century civilisation and he may well be described as an encyclopaedist.

Writing about Lomonosov, Pushkin said: "He embraced all the branches of education. The thirst for knowledge was the overpowering passion of a soul filled with passions. Historian, rhetorician, mechanic, chemist, mineralogist, artist and poet, he experienced everything and fathomed everything: he was the first to delve into the history of his country, to lay down the norms of the common language and furnish rules and samples of classical oratory; with the unfortunate Richmann he anticipated Franklin's discoveries, set up a factory, built machines all by himself, enriched the arts with mosaic works, and, finally, revealed to us the true sources of our poetic language."* If we add to this his enormous contribution to philosophy and sociology and the fact that he was the founder of physical chemistry and other branches of science, we shall obtain an even more vivid picture of his versatile creative powers.

Lomonosov was one of those brilliant men who were carrying on fundamental, painstaking and original work on new unsolved problems of many branches of science. This also fully applies to the part he played in the social sciences.

For a long period bourgeois scientists either ignored or misinterpreted Lomonosov's ideas, endeavouring to prove that he contributed nothing new to the social sciences but merely repeated the ideas and theories of the leaders of the Russian feudal and monarchistic state and of West-European sociologists. I. Tikhomirov adhered precisely to these positions in his analysis of Lomonosov's works on Russian history and political economy. In an article "On M. V. Lomonosov's Writings on the History of Russia" Tikhomirov made the absolutely erroneous assertion that Lomonosov's investigation of Gerhard Müller's studies of the history of Siberia and Voltaire's research into the history of Peter the Great, his critical remarks on these works and personal original generalisations "lack scientific value".*

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* A. Pushkin, *Complete Works* (in six volumes) (Russ. ed.), Vol. 5, Moscow, 1950, p. 25.

In another article "On M. V. Lomonosov's Writings on Political Economy" Tikhomirov tried to present matters as though Lomonosov in his work dealing with the growth and preservation of the population of Russia was merely repeating what the tsarist government was carrying out in those years. "Of course, it is a mistake to think," Tikhomirov wrote, "that the government in enforcing measures to preserve and multiply the population was guided by the ideas which Lomonosov had expressed in this treatise. What is remarkable, however, was the coincidence in the approach to the problem and that, in solving it, the government followed the lines recommended by our eminent academician."**

The historian S. Solovyov also underestimated Lomonosov's contribution to the development of Russian historical science. Solovyov claimed that Lomonosov "approached history from the standpoint of literature" and "had no clear understanding of the subject." "Historical studies were, evidently, altogether alien to Lomonosov," he wrote, and therefore, "Lomonosov's mighty talent proved wanting in his studies of Russian history and did not help him rise above the current conceptions"***, and so forth.

But what else could be expected from reactionary investigators of Lomonosov's works. They strove to portray Lomonosov as a spokesman of the ruling class of landowners and its monarchistic government. This falsification of the social and political views of the great Russian thinker was also intended to prevent the dissemination of his ideas and theories.

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* *Journal of the Ministry of Public Education* (Russ. ed.), St. Petersburg, 1912, September, p. 41.

** Ibid., 1914, February, p. 259.

*** S. Solovyov, *Collected Works* (Russ. ed.), Book 5, St. Petersburg, 1911, p. 1351.

Some mistakes in estimating Lomonosov's social and political views were also made by serious investigators of Russian social thought, such as G. Plekhanov. It must be said, however, that Plekhanov made one of the first attempts, and a fairly successful one at that, to analyse from Marxist positions the complex and contradictory process of the evolution of social and political ideas and theories in Russia.

His studies of the works of V. Belinsky, A. Herzen, N. Chernyshevsky and other great Russian revolutionary democrats are of particular importance. But his assessment of Lomonosov's extremely rich ideological heritage, alongside correct appraisals, contains scientifically groundless assertions with which it is impossible to agree. He claims, for instance, that in the social and political field Lomonosov was a conservative and, consequently, there was nothing in his works "resembling a desire to shake one or another principle" underlying the feudal and serf-system in Russia, for, allegedly, Lomonosov did not see the "dark sides of the social system of Russia of his period" and remained "indifferent to the fundamental problems of social organisation."[*]

As regards his estimation of Lomonosov as a public figure, Plekhanov does not base his conclusions on an analysis of concrete historical conditions in Russia in the first half of the 18th century. True enough Lomonosov was unable to understand the need for a revolutionary overthrow of feudal-monarchist rule. But then this could not be expected of him, if only because the social system in Russia at that time had not yet outlived itself, and, therefore, there were no objective prerequisites for transition to the new, capitalist system.

Plekhanov's assertion that Lomonosov did not see the dark sides of the social system in Russia and was not interested in problems connected with its improvement simply does not correspond to facts. On the contrary, Lomonosov was aware of many of its defects and systematically worked to eradicate some of them.

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[*] G. Plekhanov, *Collected Works* (Russ. ed.), Vol. XXI, pp. 141, 148.

By accepting the general and largely incorrect estimation of Lomonosov's role as a public figure, Plekhanov in effect also negates the new and original ideas with which Lomonosov enriched social science. "Lomonosov's vocation was natural science," Plekhanov wrote. "Here he was profound and original. His understanding of social problems, however, was superficial; therefore, his 'ideas for the improvement of public weal' were neither profound nor original.

"Anyone making a careful study of his memorandum on the growth of the population will confidently say that in this sort of observations Lomonosov could not entertain any critical views on the fundamental principles of our social system."*

Plekhanov, likewise, gives a similar appraisal of Lomonosov's role in working out vital problems of the history of Russia. "History too," he wrote, "was never Lomonosov's chief, nor even a serious vocation, although he considered that Russian men of science had to describe the accomplishments of Elizabeth's ancestors, in particular, Peter the Great.... Nothing spectacular came of his expatiation on the original sources. He had no clear understanding of any matters related to the present or the past of society."**

Investigations by many Marxists, especially after the October Revolution, irrefutably show that Plekhanov's assessment of Lomonosov's role in the development of advanced social thought is basically incorrect.

To analyse Lomonosov's social and political views correctly, we must first determine his class positions.

In the first half of the 18th century Russian society was divided into two main antagonistic classes—the landowners and the serfs—and a new exploiter class, that of the merchants, had already emerged on the historical scene.

This new class, as we have pointed out, was not playing a leading role in the life of society, although its influence was steadily increasing. In effecting economic and other reforms Peter I and his successors were supported by a section of the nobility which saw the need for these reforms and was interested in them, and also by the class of merchants. The principal force, however, which put these changes into practice, were the peasants, although they were only partially interested in them, since, in actual fact, the reforms launched by Peter I and his followers intensified the exploitation of the serfs.

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* G. Plekhanov, *Collected Works* (Russ. ed.), Vol. XXI, p. 144.

** Ibid., p. 155.

In such concrete historical conditions, Lomonosov the scientist and public leader could not but speak up for the interests and defend the policy of definite classes.

Inasmuch as Lomonosov came from the peasantry, even if from that part of it which lived in the North, that is, in somewhat different conditions from those that obtained in the central areas of Russia, he may be regarded as an ideologist and defender of the peasants' fundamental interests. But the problem is not as simple as all that. There is no doubt that among the prominent public figures and thinkers who lived in Russia in the first half and the middle of the 18th century, Lomonosov may fairly be described as a scientist who bound up his entire activity with the interests of the masses, who knew their conditions of life and who strove to the best of his ability and, as far as it was possible within the framework of a landowner-monarchistic state, to improve the position of the Russian people. Lomonosov was a fairly consistent supporter of Peter's reforms, and as a rule stood up for their progressive aspects. But since the primary purpose of these reforms was to promote the interests of the merchants and the nobility, Lomonosov's theoretical substantiation of the need to carry them out emerges objectively as an expression of the interests of these classes. Subjectively, however, Lomonosov was convinced that these reforms not only answered the fundamental interests of the nobility and the merchants, but were also intended to improve the conditions of Russia's working people.

To obtain a balanced view of Lomonosov's class positions, one must keep in mind the following Marxist tenet: a public figure, or a scientist should be judged not by his subjective ideas, but on the basis of how and what classes he serves, and what classes direct and utilise his activity. Doubtlessly, many of Lomonosov's ideas, projects and recommendations were, to one degree or another, put into practice because they served the interests of definite groups of nobles and merchants.

At the same time many of his theoretical propositions and programmes, which, in Lomonosov's opinion, could have been and should have been carried out in a landowner-monarchistic state, never saw the light of day because they were not in the interests of the ruling classes.

Thus, the essence and ideological trend of his extensive and versatile creative activity disclose certain contradictoriness of his class positions.

Plekhanov's approach to this complex issue is one-sided and insufficiently grounded. He attributes Lomonosov's "conservatism" in the social and political field to the class positions of that part of the peasantry which lived on the shores of the North Dvina and the White Sea, and views the peasant pomors as a bulwark of the monarchistic state. One cannot fully agree with Plekhanov's attempt to define Lomonosov's class views on the basis of the following generalisation: "There could be no fight against the class of government servants where this class did not exist; consequently, there could be no sentiments arising from the class struggle. In the Time of Troubles, when Bolotnikov stirred the serfs to rebel, the pomor peasants not only did not follow him; on the contrary, they supported Tsar Vasily's Moscow government. And it was their efforts that afterwards helped to restore the old and rebellion-weakened social system of the Moscow State. The spirit of independence with which they were fired had no rebellious qualities, nor anything that incited them to 'shake' any foundations whatever."*

There is no denying the fact that the pomors, who were living in slightly more favourable conditions than the serfs in many other parts of Russia, were less inclined to revolt. Nonetheless, in their overwhelming majority, they, too, were a part of the exploited class and in some measure subject to coercion.

Consequently, it cannot be said that there were no "sentiments arising from the class struggle" among them. We also cannot agree with Plekhanov that it was only these sections of the peasantry which determined Lomonosov's class positions and accounted for his "conservatism" in social and political matters.

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* G. Plekhanov, *Collected Works* (Russ. ed.), Vol. XXI, p. 141.

Lomonosov exhibited lively interest in problems related to social progress and worked on many of them. He was a passionate advocate of economic and cultural development in Russia, and a great enlightener. Under the arbitrary rule of the nobility and domination of foreigners, when the country was being plundered of its wealth and the serfs subjected to increasing oppression, Lomonosov's fight on the side of the advanced social forces against feudal and monarchistic reaction was progressive in character.

He was particularly concerned with theoretically substantiating the goals pursued by Peter's reforms and ascribed the far-reaching changes in the economy and other spheres of social activity during Peter's reign to these reforms.

With some justification he also commended those aspects of Peter's reforms which stimulated Russia's development and strengthened her independence. Between 1740 and 1770 Lomonosov's support for Peter's reforms and his demands for initiating new ones that would pursue similar goals were, undoubtedly, of a progressive nature.

Striving to substantiate the need to continue the measures inaugurated by Peter and the followers of his policy, Lomonosov somewhat exaggerated their historical role and failed to realise that many of his own ideas, recommendations and projects were utopian, for they could not be put into practice in conditions of a feudal and monarchistic system. As a rule, he analysed all social phenomena from idealist positions, placing the ideological motives, spiritual activity, etc., of great people at the root of historical changes. He sought the causes of social development primarily in the spiritual life of the people. The elements of deism which were present in Lomonosov's philosophy were revealed to the maximum in his views on society. But it should be conceded that in his opinion divine intervention had a very limited influence on social life and he virtually does not refer to it in explaining the processes taking place in history, rather seeking an answer to social phenomena in human society itself. Lomonosov's idealism lay in the fact that he clearly exaggerated the role of ideas and the consciousness of people in social processes.

Concurrently, he had many ideas reflecting his desire to show the role played by economics, industry, agriculture and trade in the life of the people, to bring to light many aspects of the activity of the masses, and determine the importance of material production for the development of science. On all these issues he expressed notions and conclusions in which materialistic trends can be traced. For instance, he attempted to assess the way economics influenced the life of society at various stages of its development from the point of view of concrete historical conditions.

In ancient times people were satisfied with what they obtained from farming, stock-raising and fishing. But as society advanced its requirements increased. "Farming, pasturing and fishing," Lomonosov wrote, "provided the first means of subsistence with which the ancient forefathers of the human race had to be content."[*] As regards more advanced society, Lomonosov pointed out that it did not tolerate such narrow confines. The developing military science, trade and navigation were incessantly demanding metals. Enlarging on the idea that metals were beginning to play an increasing role in the people's life, he made an interesting attempt to show that the metallurgical industry should steadily develop. With the view to solving this important problem, he studied the production of metals in Germany and other West-European countries, and also Russia's metallurgical industry. On the basis of his investigations he wrote and published his *Elements of Metallurgy* and *Mining,* which played a big part in training Russian specialists for the metallurgical industry. He adhered to the well-founded opinion that one of Peter's historic services was his comprehensive contribution to the development of manufactories producing metals that Russia needed. Lomonosov offered substantial grounds showing that metallurgy must play a leading role among the various branches of industry, or "arts", as he called them. He wrote: "Metallurgy, which teaches us how to discover and dress metals and other minerals, must occupy first place among all other types of industrial production. This advantage is due not only to the fact that it dates back to ancient times, which is indisputably borne out by the Scriptures and by the very accomplishments of the human race, but also to its extraordinary and fast-spreading usefulness. For metals add strength and beauty to all the important things which people use. They adorn the churches of God and make resplendent the thrones of monarchs, they are used to beat back enemy encroachments and to reinforce ships, making it possible for them to weather violent storms and safely sail the deep. Metals lay open the depths of the Earth to fertility; they are used in hunting land and sea animals that provide our daily sustenance; metals facilitate trade, for when fashioned into convenient coins they dispense with the need for tedious barter. In short, not a single art, not a single craft can do without metals."*

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[*] M. V. Lomonosov, *Complete Works*, Vol. 5, p. 401.

His theoretical elaboration of such an important problem as production of glass deserves serious attention.

In his works, especially in *A Letter on the Usefulness of Glass*, he furnishes a fairly detailed explanation of the place and role of glass in people's lives. Lomonosov, and this is very important, was the first scientist in Russia to elaborate the theory and technology and organise the production of stained glass. The Ust-Ruditsk stained glass factory was built according to Lomonosov's plan and operated under his personal supervision. Showing the necessity to build stained glass factories he argued that this would eliminate the need to import this commodity from Italy.

Lomonosov devotes much space in his works to proving the need for doing everything to develop the merchant marine, inland water transport, and foreign and domestic trade. The importance of trade was impressed on Lomonosov when he was still a youth living in the North, where trade was conducted on a relatively greater scale than in many regions of Russia. He highly praised the considerable successes attained in the development of the merchant marine and maritime trade during the reign of Peter the Great. This is how he describes them:

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* Ibid., Vol. 2, pp. 359-60.

"The vast Russian state is like a world almost completely surrounded by great seas forming its frontiers. We see unfurled Russian flags on all of them. In one place there is barely enough space in the mouths of the mighty rivers and in the new harbours for the numerous vessels; elsewhere waves are groaning under the weight of the Russian fleet, and the deep rumbles like a volcanoe. There are gilded ships, as lovely as spring in bloom, enhancing their beauty by reflecting it on the calm surface of the water; elsewhere, to our pleasure, a voyager from distant lands, having reached safe shelter, is unloading his riches. There are new Columbuses hastening to unexplored shores to augment the might and glory of Russia."*

Nevertheless, the notable headway that had been made in building up the merchant and river fleets and the construction of sea harbours, in the expansion of foreign trade, and in training Russian specialists did not satisfy Lomonosov. Comparing the Russia of the first half of the 18th century with advanced West-European countries, he pointed out that in this respect she was lagging far behind them. Many people, foreigners in particular, alleged that her backwardness was due to the inability of the Russian people to solve these problems without outside assistance. Lomonosov firmly rejected this deliberate disparagement of the Russian people, and sought to discover the true causes of the situation. Among the objective reasons underlying Russia's lag in development of foreign trade in comparison with advanced West-European countries, Lomonosov discerns the prolonged absence of sea ports, not counting Archangel. "Although foreign trade has expanded considerably in the East and the West in the current century," he wrote, "it is undeniable that we are far behind some European countries, which are extensively trading with all parts of the world, but which are not trading sufficiently with Russian lands. But Russia is not be blamed for this, for in view of their geographical position the West-European powers have broad access to the great seas and, consequently, long-standing experience in navigation and in designing ships capable of making long voyages. Russia, with her vast territory, has only one harbour at Archangel. And even this recently constructed port was used mostly for internal trade along the great rivers. Now that Peter has built harbours on many seas and has opened schools for navigators and ship-builders, former inconveniences have disappeared and naval and merchant ships are beginning to cover ever greater distances. In this respect we shall, with time, not only catch up with other maritime countries, but even surpass them, provided we put all things with which Providence has blessed our vast country to good use."*

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* M. V. Lomonosov, *Complete Works*, Vol. 8, pp. 597-98.

Lomonosov wanted Russia become a highly-advanced, strong sea power. But these hopes were not and could not be realised in a landowner-monarchistic state such as Russia was at that time. His noble aspirations became reality only after the Russian nation, whose praises he sings with such talent, had overthrown the rule of the landowners and the bourgeoisie, and built socialism under the guidance of the working class and its Marxist party.

Lomonosov was one of the first among the advanced Russian thinkers to make quite a large number of scientifically interesting sociological generalisations about the historical role of the Russian people.

The feudal and religious ideology that for centuries had dominated Russian thought completely negated the role of the masses in the history of society. All changes in the life of the Russian and all other societies were ascribed to Providence, or to the efforts of tsars, princes, and secular and spiritual feudal lords. The reactionary ideologists of Russia's landowner-monarchistic system tried in all manner of ways to prove that the lot of the working people was to bow in submission to the will of their masters.

Bearing this in mind, Lomonosov's efforts to shed light on some aspects of the historic role of the Russian people are of great scientific interest. Although he did not go beyond the limits of the ideology of his time, many of his concepts about the role of the Russian people contradicted this ideology and encountered sharp opposition on the part of its advocates.

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* Ibid., Vol. 6, pp. 421-22.

On the basis of a thorough study of the history of Russia and other countries and thanks to a good knowledge of the life of the people, founded primarily on personal observations, Lomonosov came to the conclusion that the talented, courageous and enterprising Russian people by their gallant struggle against nature and foreign conquerors had contributed a great deal towards the formation of a mighty independent state. "From time immemorial to the present day," he wrote, "the Russian people have seen so many changes in their life, so much disunity, oppression and disorganisation caused by internecine strife and wars against foreign invaders, that it is indeed amazing that they have not only survived all these hardships but also risen to the heights of greatness, might and glory. Neither foreign invaders—Hungarians, Pechenegs, Polovtsi, Tatar hordes, Poles, Swedes and Turks—nor domestic strife could exhaust Russia beyond recovery. Each disaster was followed by periods of still greater prosperity, and each decline by still greater restoration; and to the satisfaction of the weary people Providence chose to give them vigorous monarchs."*

In the light of the above it follows that in Lomonosov's opinion Russia owed her ability to overcome numerous difficulties in the first place to the unselfish, heroic efforts of the Russian people. And even if he did mention Providence and monarchs, he, nevertheless, did not consider them the true makers of Russian history.

He credited the Russian people with independently solving complex problems in farming, industrial development, military engineering and other spheres of social life. He was firmly convinced that the Russian people could reach the heights of knowledge and culture and successfully work on the most difficult scientific problems. "It is a matter of honour for the Russian people," he wrote, "to show their aptitude and ability in the sciences, and to demonstrate that our country can use its sons not only in military valour and other spheres, but also in matters of great learning."*

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* M. V. Lomonosov, *Complete Works,* Vol. 6, p. 169.

To illuminate the historic role of the Russian people more fully, it was essential to determine their origin and the principal stages of their development, to compare it with other peoples, to give a scientifically argumented rebuff to all those who had either belittled, or negated their contribution to historical progress, and to conduct painstaking scientific research into all these issues. It was with this aim in view, and not to humour the whim of Elizabeth or her statesmen, that Lomonosov, with his inherent thoroughness, started to work on vital problems of Russian history. This was all the more necessary because Müller and some other historians of the period had drawn a distorted picture of the history of the Russian people.

Lomonosov refuted the attempts of foreign and Russian reactionary historians to belittle the role of the Russian people in world development. He was particularly sharp in his criticism of Müller's slanderous fabrications. In his notes on Müller's *Origin of the Name and People of Russia*, Lomonosov wrote: "Mr. Müller says (p. 13): '. . . our ancestors are called Slavs (Slava means glory—*Ed.*) because of their glorious deeds'. At the same time, however, he endeavours to prove the opposite in his thesis, for almost on every page Russians are beaten and *successfully* plundered, the victorious Swedes reduce them to ruin and kill them off with sword and fire; Huns drive them off to war and slavery. All this is so preposterous that if Mr. Müller possessed a more vivid style of writing he would have drawn a more pitiful picture of the Russian people than any writer ever drew of even the weakest of nations."**

As regards Voltaire's *History of the Russian Empire under Peter the Great*, Lomonosov who, on the whole, had a high opinion of this work, nevertheless criticised the author for exaggerating the role of foreigners in Russia's historical development and belittling the contribution of prominent Russian men of science and art. In his notes on this book Lomonosov made the well-founded observation that in its fourth chapter the great French enlightener underrated the part played by Peter I and other prominent Russians and overrated the efforts of Lefort and other foreigners in state affairs, including the building up of a powerful Russian army.

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* P. Pekarsky, *History of the Imperial Academy of Sciences in Petersburg* (Russ. ed.), Vol. II, St. Petersburg, 1873, p. 847.

** M. V. Lomonosov, *Complete Works,* Vol. 6, p. 21.

Moreover, in his critical remarks on the above works, Lomonosov provided his own solution to conflicting problems.

In history, as in other branches of knowledge, he recognised only works based on serious, thoughtful study of records and historical facts and which contained a truthful account of events. He himself followed these principles during his investigations into Russian history. As an advocate of a genuinely scientific approach to historical events and all other phenomena, Lomonosov sharply criticised all those who by devious ways distorted historical truth and departed from scientific rules and logic. This was vividly manifested in his polemic with Müller on certain important aspects of Russian history.

At first, with inherent scientific thoroughness Lomonosov came out with well-grounded criticism of Müller's one-sided and fallacious notions. Müller's reply contained point-by-point explanations and counter arguments, most of which lacked scientific reasoning and were not intended to establish historical truth. Lomonosov studied Müller's reply and on the basis of new concrete material once again convincingly proved that Müller's concepts did not hold water and that his approach was basically incorrect. Summing up, Lomonosov listed four general defects in Müller's treatment of scientific disputation:

"1. Obscure ideas and examples disjointedly heaped on one another for the purpose of concealing the truth and confusing the reader with contradictory ideas.

"2. Citing quotations (or to be more correct, quotations which he himself invents), as a means of replying to objections raised by others.

"3. Inventing things and then ascribing them to us; by distorting our arguments and then refuting these distortions, it seems, he is celebrating a brilliant victory over shadows and dreams.

"4. Abuse and calumny with which he tries to intimidate us; but this is a blunt weapon and harmless lightning."[*]

Lomonosov opposed empiricism in the study of history. He held that genuine historians cannot confine themselves solely to gathering and describing historical facts and events, but that they should, with the help of scientific theory, explain the reasons occasioning these events and disclose their substance. In other words, they should investigate historical phenomena in the manner of scientists who are studying physical, chemical and other natural phenomena.

Lomonosov has rendered valuable service to Russian historical science by setting forth some of its theoretical principles.

Academician B. Grekov, an eminent Soviet historian, has a high opinion of Lomonosov's works on Russian history. "Lomonosov was well aware," he writes, "that a historian must have facts at his disposal. And he began to gather them. He was also well aware that it was not enough merely to gather facts, and that a scientific orientation in a multitude of facts requires theory."[**]

In the draft of the new rules for the Academy Lomonosov discussed the subject matter and purposes of various fields of knowledge including history. He adhered to the opinion that a real historian should "in addition to his knowledge of world history, especially Russian history, also know practical philosophy, law, politics and rhetoric".[***] Developing the thought that history as a science must have its theory, he arrived at the conclusion that such a theory should be elaborated on the basis of philosophy. In the same draft rules we read the following: "The compilation of a complete history of Russia in the manner of the great ancient historians, as were the Romans Livy and Tacitus, is not a job any historian can accomplish, for as far back as mankind can remember there have been only a few such men among all peoples, considering that interpretation of history requires a profound knowledge of philosophy and rhetoric."[*] Accordingly, Lomonosov held that anyone working on the history of Russia should be "dependable and truthful",[**] that he should be of "Russian birth" and "should not be inclined to falsehood and ridicule in his historical writings".[***]

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[*] M. V. Lomonosov, *Complete Works*, Vol. 6, p. 52.

[**] *Marxist Historian* (Russ. ed.), 1940, No. 11, p. 26.

[***] M. V. Lomonosov, *Complete Works*, Vol. 10, p. 140.

Lomonosov was a real scientist and as such there was nothing dilletantish in his approach to historical science. He spent a long time both in amassing and studying factual material and in elaborating the theory of historiography. In working on problems of historical science he critically studied the writings of his predecessors and contemporaries both in Russia and in the West-European countries.

The thoroughness with which he conducted research into Russian history is also revealed in his reports on what he had accomplished up to a certain period. For instance, in his report to the Academy's President covering the years 1751-56 he wrote that in 1751 he read the following books "for the purpose of gathering material for his Russian History: Nestor's writings, the Laws of Yaroslavl, the *Big Chronicle,* the first volume of Tatishchev's works, works by Cromer, Waissel, Helmold, Arnold (Arnold von Lubeck —*Ed.*) and other authors from which I selected excerpts and notes, all told 653 points on 15 sheets".[****]

Further he states: "I have studied 15 volumes of Russian historical manuscripts, which I collected in the current year (1756—*G.V.*) for my library, so as to compare their descriptions of historical events."[*****]

Lomonosov also dealt with the important and very complicated problem of determining the origin of the Russian people. Müller and other historians, borrowing from insufficiently reliable foreign sources, advanced what is known as the Norman theory of the origin of the Russian people. Lomonosov counterposed this anti-scientific idea with his own solution to the problem. Müller and other foreign historians asserted in support of their erroneous conception that the Slavs had only comparatively recently settled on Russian lands, and cited the fact that ancient Roman and other Western historians did not mention the Slavs in their works. Lomonosov replied with the following cogent argument: "Although the Slav people and their language have an ancient history, the name Slav became known to foreign writers at a much later period, probably not before the reign of Justinian the Great. Peoples do not spring from names, but names are given to peoples. Some are called by their own name, or have the same name as their neighbours. Sometimes a people calls another people by a name which is altogether alien, or even unknown, to the latter. Often a new name obliterates the old, or an old name, having transcended domestic limits, is thought to be a new one by foreigners. Hence it is quite likely that the Slavs called themselves Slavs long before this name was heard of and became accepted in Greece or Rome."*

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[*] M. V. Lomonosov, *Complete Works,* Vol. 10, p. 148.

[**] Ibid.

[***] Ibid., p. 149.

[****] Ibid., p. 389.

[*****] Ibid., p. 393.

He approached this question from all angles. Besides studying historical manuscripts, chronicles and so forth, he devoted much attention to problems of the Russian language. As a result of painstaking study of Russian history he succeeded in proving that Russian and other Slav peoples had settled on Russian lands long before our era. He rightly asserted that no people can appear in a flash. "The greatness and might of the Slav race," he wrote, "whose size has remained almost unchanged for more than 15 centuries, is sufficient and well-nigh obvious proof of its antiquity; it is impossible to imagine that in the first century after the birth of Christ it should have suddenly grown to proportions defying the course of human development and all-known rates of restoration of great peoples."**

Lomonosov studied the names of Russian cities and villages and once again proved the correctness of his proposition.

"The second principal part of this thesis," he wrote in his critical remarks on Müller's work, "treats of the Slav people who came to these places much earlier than Mr. Müller thinks. This is indubitably proved by the Slav names of ancient Russian cities. It would have been impossible for these cities to have Slav names if the Slavs had settled here as late as the 4th century. That the Slav people had settled in Russia as far back as before the birth of Christ can be irrefutably proved."* All this was subsequently corroborated by Russian historical science and archaeology.

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* Ibid., Vol. 6, p. 178

** Ibid.

As regards the Slav name itself, or rather the various names of this numerous people, here, too, we should agree with Lomonosov who insisted that the "name Slav reached the ears of foreign authors long after it had appeared" and that this in no way "contradicts the antiquity of this people".**

Lomonosov gives good reasons for asserting that the Russian and other Slav peoples self-sacrificingly and gallantly defended their land against numerous foreign encroachments. In particular, he mentions that Russian troops under Alexander Nevsky fought to preserve the independence of their country against invading forces of Livonian Germans and Swedes.

Lomonosov believed that no historian should conceal the difficulties, privations and calamities suffered by the people. It should be shown what great difficulties Russia encountered in her rise to power and glory, and how they were surmounted. But these facts, he said, were "known to very few people for no true account of the events in Russia is available. Consequently, nothing is known of the great services rendered Russia by her monarchs, the glorious name of the ancient Russian people is left in obscurity, and valorous exploits and wise acts remain unrelated. My sincere love for Russia and desire to be of service to her have inspired me to rectify this shortcoming to the best of my ability".***

Although in his historical investigations Lomonosov endeavoured to adhere to this principle he could not avoid making a one-sided, idealistic assessment of a whole range of historical events.

Lomonosov also played an important part in interpreting the history of social struggle in Russia at the close of the

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* M. V. Lomonosov, *Complete Works*, Vol. 6, pp. 21-22.

** *Marxist Historian* (Russ. ed.), 1940, No. 11, p. 30.

*** M. V. Lomonosov, *Complete Works*, Vol. 6, p. 15.

17th and the beginning of the 18th century, by scientifically treating some of the events that took place in those years. In his *Description of the Streltsi Mutinies and the Reign of Sophia,* in remarks on Voltaire's *Histoire de l'empire de Russie sous Pierre le Grand,* in the memorandum on the preservation and reproduction of the Russian people and in other works he strove to disclose the causes of discontent of the masses. Of particular interest is his description of *streltsi* mutinies, in which he came close to a correct appraisal of their causes.

"... The *streltsi,*" he wrote, "tyrannised by their commanders, who made them perform all manner of jobs even during holidays and underpaid them on various pretexts, wrote a petition to the tsar requesting adjustment of all grievances. They dispatched one of their number to deliver it to the *Streltsi Prikaz* (office—Ed.). Yazykov, a nobleman, member of the Duma and Councillor of the Chancellory, accepted the petition, promising to report the matter to Prince Y. Dolgoruky who was the chief of the Department and said that a reply would be forthcoming on the following day. Yazykov promptly went to the Prince but distorted the matter in his report. He said that the man who delivered the petition was drunk and was even disrespectful in speaking of the Prince. Thereupon, Prince Dolgoruky said that if the man was drunk, he should on the morrow be whipped in front of the *streltsi* quarters as an example for the others.

"The next day, when the man arrived at the Department for a reply, he was told that the tsar had ordered him to be punished as a mutineer and to be whipped for others to see."* Lomonosov further writes that the punishment meted out to this man evoked an outburst of indignation and directly incited the *streltsi* to mutiny.

I. Sukhopluyev in an article entitled "Lomonosov's Views on the Population Policy" correctly observes that "Russian economists, statisticians, policy-makers and executives ignore Lomonosov's views on the population policy".** But he does not disclose the real reasons why Lomonosov's progressive ideas were relegated to oblivion. Much of what Lomonosov suggested by way of preserving and multiplying the Russian people clashed with the interests of the reactionary ruling classes of tsarist Russia. Moreover, the fundamental idea and the political trend of his proposals in large measure contradicted the ideology of these classes. Lomonosov approached the problem of promoting the growth of population according to his views on the place and role of the masses in the development of the country. For example, he considered that a country's prosperity in great measure depended "on internal peace, security and the well-being of its subjects", that is, of the masses. Further, he reasoned that the growth of population depended on improvement in living conditions and morals, on public education, etc. Speaking of the causes which induced him to make recommendations on this issue, Lomonosov wrote: "I cannot leave anything that might benefit society (if only in my imagination) hidden from the light of day."* He continued by expounding measures which he thought would "add to the public weal" and particularly emphasised that the chief task was to preserve and multiply the population of Russia "in which lie the greatness, might and wealth of the state, and not in its vast territory, which is useless without inhabitants".**

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* Ibid., p. 133.

** *Lomonosovsky Sbornik* (Russ. ed.), St. Petersburg, 1911, p. 165.

Most of Lomonosov's proposals, from his remarks on unequal or enforced marriages and religious holidays to the organisation of an efficient medical service for the masses and mitigating "landowners' oppression of the peasants" are full of concern for those who carried the full burden of providing for Russian society. It was not his fault, but rather his misfortune that he was sincerely convinced that all these measures could be carried out in a landowner-monarchistic state and by its ruling classes themselves. He was sure, for instance, that it would be enough to explain to Shuvalov and other statesmen the need to organise large-scale training of doctors, teachers and other specialists from among the ordinary Russian people and they would at once launch such measures and stop inviting specialists from abroad. Lomonosov made no bones about his stand on the matter in the following recommendation: "The Medical Chancellory should be firmly instructed to make sure that pharmacies and doctors have an adequate number of Russian pupils, whose training they should complete within a set period of time and then introduce them to the Senate. It is disgraceful and vexing that after working for 10 or more years in pharmacies Russian pupils are practically unable to compound medicines. How can this be explained? Apothecaries also have foreign pupils, while Russians who are attached to the mortar, the seive and the furnace grow old and die as apprentices. But you cannot fill the whole country with foreigners. Moreover, their inadequate knowledge of Russian, different faith and habits, and higher remuneration create additional difficulties."*

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* M. V. Lomonosov, *Complete Works*, Vol. 6, p. 384.

** Ibid.

We have already mentioned that a whole range of Lomonosov's suggestions and projects of a socio-economic nature which coincided with the interests of the certain sections of the exploiter classes were either fully or partially carried into life. On the other hand, many demands and proposals aimed at promoting the growth of productive forces, improving the material level of the peoples, and so on were completely ignored. M. Ptukha in his informative and interesting article "M. V. Lomonosov, Economist and Statistician" makes the following assertion with which one cannot fully agree: "It should be noted that the measures enforced by Catherine II three years after Lomonosov's death reflected his general thoughts on economic reforms for the benefit of the people."** But in this case, too, the tsarist government acted only on those projects and plans drawn up by Lomonosov which conformed to the interests of the ruling classes.

Lomonosov was also deeply interested in determining the part played by outstanding personalities in social development. He had many original ideas concerning the place and the role of prominent statesmen in economic, political, military and other affairs. Like other sociologists of his time, he overrated the merits of individual princes, tsars, military commanders, etc. This was not surprising, for the low level of social sciences and lack of knowledge of the principal causes and objective laws of social processes made a correct approach to this important problem impossible. Lomonosov displayed this tendency most fully in his interpretation of Russian history. His principal work in this field *Ancient Russian History from the Origin of the Russian People Up to the Death of Grand Prince Yaroslav I or Up to 1054*, especially its second part "From the Beginning of the Reign of Prince Ryurik Up to the Death of Yaroslav I", chiefly describes the activity of the first Russian princes. His *Short Russian Chronicle* is written in the same vein. Here he exaggerated the role played by the princes in historical development and made practically no attempt to analyse the activity of the masses. He divided the history of Russia into periods according to the names of princes. It should be borne in mind, however, that the documents which Lomonosov had at his disposal permitted him to study only the life and work of princes and some other statesmen.

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* Ibid., p. 397.

** *Lomonosov.* Collection of Articles and Documents (Russ. ed.), Vol. II, U.S.S.R. Academy of Sciences Publishing House, Moscow, 1946, p. 154.

Of great interest to us in determining Lomonosov's views regarding the role played by outstanding personalities in social processes are his works describing the life of Peter the Great. The very fact that Lomonosov was mostly concerned with investigating Peter's manifold creative activities leads one to the conclusion that he judged highly of statesmen who worked for the progressive development of society, science and culture. By regarding Peter as an ideal example of this type of statesman, Lomonosov plainly exaggerated his merits, making him an object of hero worship. He wrote, for instance, that "if we had to seek a man, who, in our understanding, resembled God, I know of no other than Peter the Great"*, that "Peter, having saved Russia from plunder, dispelled dark fear and brought with him a safe and serene joy", that he defeated "foreign enemies and wiped out traitors",** that "his deeds and eloquence are unmatched,"[*] and so forth. The fact that Lomonosov devoted so much deal of attention to Peter's historical activities shows that in his opinion the role of statesmen in social development was not always the same.

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* M. V. Lomonosov, *Complete Works*, Vol. 8, p. 611.

** Ibid., p. 586.

Lomonosov held that the leading part in the economic reforms carried out in Russia at the close of the 17th and the beginning of the 18th century was played by Peter I and claimed that he was responsible for her rapid industrial development.

From the same angle Lomonosov assessed Peter's part in stimulating trade, building of the merchant marine and the river fleet, erecting the new capital and other cities, etc.

To be sure, Peter did make a big contribution to all the manifold changes. But there is also no doubt that Lomonosov rated Peter's efforts to promote Russia's economic development from a historically limited point of view.

Lomonosov also considered that the far-reaching educational reforms in Russia were due solely to the efforts of this enlightened monarch, and claimed that Peter partly by injunction and partly by his personal impressive example induced a great many of his subjects temporarily to leave their country to study various trades, for interesting voyages through foreign lands benefited both the traveller and the state. "Thereupon," he continued, "Russia flung open her great gates, and her sons bound for distant lands to study sciences and arts, and foreigners skilled in arts arriving with books and instruments began to stream across her frontiers and through her ports, their incessant movement resembling the ebb and flow of the great ocean".[**]

Peter's contribution to the numerous victories of the Russian army in the first quarter of the 18th century is also clearly overestimated by Lomonosov.

But when we speak of Lomonosov's historically limited and idealistic account of Peter's activities, we should also note that it does contain a certain amount of historical truth. It is also important that his estimation of other prominent personalities is almost completely devoid of such idealisation. In his opinion, many other statesmen, unlike Peter, possessed many negative qualities. There were many military leaders, Lomonosov wrote, "who conquered many countries but showed no concern for their own," or who had "shed the blood of their people solely to attain their ambition and, instead of being hailed with triumph, were greeted by a weeping mother-country".*

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[*] Ibid., p. 590.

[**] Ibid., p. 591.

Finally, Lomonosov sharply censured the activity of many high-ranking persons, among them the foreigner Biron, who opposed reforms intended to promote Russia's well-being and stimulate her scientific and cultural development.

As regards the lofty odes which he had to compose, he but paid tribute to the times in them. Assessing this fact, allowance should be made for the conditions in which he lived and worked.

Lomonosov was also deeply concerned with spreading knowledge and educating the masses. He wrote that only by training a large number of qualified Russian specialists in all branches of science and engineering would it be possible to raise Russia to the level of the most advanced countries.

Without denying the need to invite a certain number of foreign specialists and scientists for work in Russia, he also observed that this policy had its negative aspects.

The fact that a whole group of foreign scientists were invited to Russia, he wrote, "made people in other countries think that we, allegedly, had no hope of Russians ever becoming professors or occupying other high positions." He continues: "What else can one think when reading instructions which speak of inviting a foreign specialist in higher mathematics and other professors, attaching Russian assistant-professors as interpreters to foreign professors, translating their books, concluding contracts with them and employing foreigners as chancery clerks and print-shop directors... What else can one think but that the St. Petersburg Academy of Sciences now and in the future must consist for the most part of foreign scientists, that is, that

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* M. V. Lomonosov, *Complete Works*, Vol. 8, p. 611.

Russians are incapable of acquiring the necessary knowledge".[*]

In order to disprove the absurd reactionary theory that by their very nature Russians were incapable of independently developing engineering, science and culture, it was imperative to begin the training of young Russians on a broad scale. Hence Lomonosov's persistent efforts to organise and improve university and secondary education. He wanted universities to become centres preparing specialists in all fields. To the gymnasiums and secondary schools he assigned the double role of preparing people for university studies and training specialists in certain specific fields.

He wholeheartedly supported democratisation of schools, and demanded that both schools and universities should be opened to the broad public. Lomonosov knew how difficult it was for an ordinary person to acquire an education because he had had to pose as a son of a clergyman in order to enter the Moscow Slavonic-Greek-Latin Academy. As for the nobles, he writes, they "are more inclined to send their children to the Cadet Corps than to the Academy, for it is their chief fear that after long years of study at the latter the highest rank they may hope to attain will be that of captain, which makes them loth to study at the Academy".[**] The children of commoners, however, would have eagerly taken up scientific studies so that they could subsequently contribute to Russian science and the work of the Academy. He, therefore, demanded that gymnasiums, the University of the St. Petersburg Academy and Moscow University be granted such privileges as non-interference on the part of religious organisations, the censor's office and the police. He strove to make gymnasiums and universities accessible not only to the privileged classes but also to the commoners. "Other European countries," he wrote, "have plenty of people of all ranks who become scientists, and no one is forbidden to study in universities, and a student is judged by the progress he makes in his studies and not by his parentage. Here, in Russia, there are not enough learned men: the nobility does not want to study at the Academy, for this holds no prospects of high position or rank; at the same time those who are subject to poll tax are forbidden to study there. Perhaps the person who drew up these rules thought that it would be a great burden to Russia to lose 40 altyn[*] a year for the sake of acquiring one Russian scientist; but even if we allow that this sum was too great and that the 1,800 rubles, the cost of inviting one foreign scientist, was not too great, why should those poll-tax years who themselves can afford to pay for the education of their children be held at fault? And why is entry completely barred to all, without any distinction being made between gifted townspeople and serfs?"[**] Lomonosov's persistent efforts to place gymnasiums and universities within reach of peasants' children were of no avail. The class nature of Russia's educational institutions in the mid-18th century was vividly manifested in Article 26 of the "Plan for the Foundation of Moscow University", which stated: "Whereas now the sciences can tolerate no coercion and are held to be among the most noble occupations of man, therefore serfs and other people owned by landlords shall not be admitted to studies either in the university or gymnasium."[***]

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[*] Ibid., Vol. 10, pp. 52-53.

[**] Ibid., pp. 53-54.

As early as 1748, Lomonosov wrote in connection with the elaboration of new rules for the University: "It would do no harm if the University and the Academy, as is the case in foreign countries, were granted certain privileges, particularly freedom from police duties." Later a sharp polemic took place between Lomonosov and I. Shuvalov, who was charged with the organisation of Moscow University. Shuvalov vigorously opposed Lomonosov's efforts to make the University an educational institution that could take independent decisions on all matters related to training Russian specialists, promoting scientific progress, etc.

In this respect Lomonosov was not entirely unsuccessful. Thanks to him the Moscow University Charter in some measure protected professors from police and church interference. Article 7 of the "Plan for the Foundation of Moscow University" stated: "All professors are instructed once a week, namely, before noon on Saturdays, to gather in the presence of the director for meetings at which all matters related to studies and measures for their improvement should be discussed, and at which every professor should inform the director about everything his department requires or what has to be adjusted there. The meetings shall also decide all student matters, and determine the punishment to be meted out should any of them be guilty of insolence or misconduct."* According to the Charter, the university professors and gymnasium instructors were subordinated only to the curator and the director, and only the university authorities were permitted to punish students for reprehensible behaviour.

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[*] One altyn=3 kopecks.—*Ed.*

[**] M. V. Lomonosov, *Complete Works*, Vol. 10, pp. 55-56.

[***] N. Penchko, *Founding of Moscow University* (Russ. ed.), Moscow University Publishing House, 1953, p. 156.

Most of the freedoms which Lomonosov sought for universities and gymnasiums were not granted, however. He wanted, for instance, to fence off educational institutions from church interference, and championed complete independence for science, research and the spread of scientific ideas. His draft rules for the University stated: "The clergy should not meddle in the studies of physics whose truth serves to enlighten people; in particular they should not rail at sciences in their sermons."** But this demand was virtually ignored in the University rules. The Synod constantly interfered in the affairs of the Academy, universities and gymnasiums and persecuted scientists for spreading ideas undermining religious principles. This is borne out by Lomonosov's sharp conflicts with the higher clergy and the persecution to which he was subjected by the Holy Synod for spreading materialist ideas.

Lomonosov was among the first to make a firm stand against the domination of foreigners in Russian educational, scientific and cultural institutions. Guided by a true love of his country, he concentrated efforts on the organisation of training for Russian specialists and achieved considerable success in this. He himself prepared a group of Russian scientists who played an important role in promoting Russian science and culture and the training of local specialists in the second half of the 18th century.

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* Ibid., p. 153.

** P. Bilyarsky, *Documents for Lomonosov's Biography*, St. Petersburg, 1865, p. 418.

His theory on the role of science in social life also deserves special mention. He was emphatic that investigation of natural and social phenomena should serve the interests of mankind, and many of his works give good reasons for introducing scientific and technical achievements into people's lives. Suffice it to mention his *Report on the Usefulness of Chemistry*, *On the Earthquake Origin of Metals*, *Elements of Metallurgy and Mining* with the addenda *On the Earth's Strata*, *Letter on the Usefulness of Glass* and others, to see how deeply Lomonosov was absorbed in this vital problem.

Surveying the marked changes that took place in Russia between the end of the 17th and the middle of the 18th century, Lomonosov noted that many scientific and technical achievements had been introduced in all walks of social life. "The usefulness of various sciences and trades," he wrote, "is clearly manifested in the abundance of diverse goods which we now have and which were not available or even known to our ancestors who lived before the reign of the Great Enlightener of Russia. Today, many useful goods previously imported with great difficulties and at a high price from foreign countries are manufactured in Russia herself in quantities that allow us not only to satisfy our own needs, but also to send some of them to other countries. Our neighbours were once wont to say that Russia, a great and powerful state, relied on them in developing military engineering and trade, for she lacked the metals for stamping coins and manufacturing weapons with which to repel her enemies. Peter's enlightenment has put an end to this belief: thanks to his strenuous efforts, we are now producing enough metal to meet the needs of our country and to sell it on credit to foreign lands. Gallant Russian soldiers are fighting the enemy with weapons made of Russian metal and by Russian workers."*

Lomonosov believed science should play a great role in boosting industry, agriculture and trade, that it should be placed at the disposal of government organisations engaged in prospecting and mining minerals, etc. Accordingly, he drafted many scientifically-argumented projects and it was not his fault that they were turned down. One of these programmes provided for a comprehensive survey of Russia's natural wealth with the help of local inhabitants. Enlarging on this idea he wrote: "Let us explore our mother-country, study her lands and discover which places have ores and which have not, and then on the basis of our studies of the richest deposits discover other ore-bearing areas. We shall search for gold, silver and other metals, and mine valuable stone such as marble, slate, and even emeralds, rubies and diamonds. Our road will be an interesting one. To be sure we shall not come across treasures in all places, but wherever we go there will be useful minerals whose extractions will bring much benefit to society."[*]

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* M. V. Lomonosov, *Complete Works*, Vol. 8, pp. 591-92.

Lomonosov's example inspired people of future generations to study Russia's incalculable natural wealth.

He also worked on a broad programme of socio-economic investigations tied up with the concrete economic tasks facing Russia at the time. On July 15, 1759, in a report presented to the Academy of Sciences, he made this suggestion: "Following the example of other countries, I consider it advisable for the Academy to organise the publication of *Russkiye Vedomosti* (Russian Gazette—*Ed.*), which, by reporting the domestic situation, and by writing about the goods the country lacks and those that are in abundance, would help the national economy, private persons, and especially merchants, to work in the direction that would benefit the country most: for instance, it should contain information about good or bad harvests, exports and imports and other matters which should be brought both to the knowledge of official bodies and private individuals, particularly merchants and people engaged in other business occupations. I am forwarding this report to the Academy Chancellory for it to be submitted for approval to His Excellency the President of the Academy, particularly on the following points:

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[*] Ibid., Vol. 5, p. 620.

"1) *Vedomosti* is to be printed only in the Russian language;

"2) it should contain all news carried by ordinary gazettes;

"3) in addition to political news it should contain scientific reports, reviews of new books, etc.;

"4) publication should begin in the new year of 1760;

"5) the Senate should be requested to organise dispatch of news from gubernias and towns in accordance with the plan drafted by the Academy."*

This plan as well as the publication of his socio-economic investigations in Russian were also shelved during his lifetime. There are reasons, however, to think that some of the suggestions he made in this plan and in other works were taken into account when the Free Economic Society of Russia was founded in 1765.

The issue of war and peace was another social problem which deeply interested Lomonosov. Studying the history of his and other peoples, Lomonosov arrived at progressive sociological conclusions. He maintained that the Russian people had, as a rule, waged defensive wars in which they had repelled enemy invaders who sought to subjugate their land.

In his *Ancient Russian History* he stressed that the Russian people had fought prolonged and bitter defensive wars against Tatar hordes, Poles, Swedes, Turks and other foreign invaders.

Lomonosov censured those governments and statesmen who violated peace, attempted to conquer other lands, etc. His magnificent *Ode ... on the Victory over the Turks and the Tatars and Taking of Khotin* vehemently denounces the Turkish leaders who organised frequent campaigns against Russia in an effort to subjugate her. The victory of the Russian troops and the taking of Khotin proved that the Russian army was powerful enough to repel foreign encroachments. The same ideas permeated his ode dedicated to the victory over the Prussian troops. For several centuries, beginning with the attacks by Teutonic knights and ending with the reign of Friedrich II, Prussian reactionaries had launched military campaigns against the Slav peoples, including Russians. In 1759, Russian troops smashed Friedrich's army and entered Berlin. Lomonosov came close to making a correct appraisal of the part played by Russian troops in frustrating the aggressive plans of Prussian militarists headed by Friedrich II.

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* M. V. Lomonosov, *Complete Works*, Vol. 10, pp. 78-79.

Recognising the inevitability of defensive wars, Lomonosov, nevertheless, was well aware that any war brings countless sufferings upon the people, and this made him an ardent champion of peace. In the *Ode on the Taking of Khotin* he praises the gallantry of Russian soldiers and at the same time dreams of the enduring peace which Russia needed to promote the well-being of her people.

"A country's well-being, glory and prosperity," he wrote in one of his works, "have three sources. The first derives from internal calm, and the safety and contentment of its subjects; the second, from victorious battles against enemies followed by the conclusion of an advantageous and honourable peace; the third, from mutual trade with other lands carried on by merchants."*

Lomonosov believed that a country should maintain an army not for the purpose of unleashing war or forcibly enslaving other peoples, but "for its own defence, for the safety of its subjects, for the unhampered enactment of important government measures within the country".** It is from these positions that he views Peter's military reforms that led to the establishment of a new army which, according to Lomonosov, did not pursue aggressive aims but only defended the independence and honour of the people. He credited Peter with imbuing Russian troops with precisely such a spirit and held that Peter was creating an army not because he sought to "rule Rome", but to defend his country.

Describing the victories of Russian troops under Peter, he wrote: "By his splendid victories the Great Monarch won world renown for himself and his army. He also showed that the army was formed more to ensure the safety of Russia by decreeing that it should never be disbanded even in times of tranquil peace, which was something that was not done by preceding monarchs and often sadly lessened the might and glory of our motherland, and to maintain it in a state of preparedness. Truly such solicitude is worthy of a father."*

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* Ibid., Vol. 6, p. 421.

** Ibid., Vol. 8, p. 592.

There are two noteworthy aspects to Lomonosov's appraisal of the Russian army. The first reflects his sincere belief that Russian soldiers personify a force whose lofty goal is to crush all encroachments on the sovereignty of Russia and to ensure durable peace. The second reveals a certain idealisation of Peter's policy and that of his followers on matters of war and peace. It is known that in the 18th century Russia's exploiter classes and their governments certainly did not wage only defensive wars; they quite often launched wars for the purpose of conquering other lands and other peoples.

Lomonosov played an important role in stimulating the growth of advanced sociological concepts in Russia in the first and the beginning of the second half of the 18th century. In subsequent years his progressive ideas continued to exert a beneficial influence on social and political thinking.

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* M. V. Lomonosov, *Complete Works*, Vol. 8, p. 597.

Chapter III

LOMONOSOV AS AN ADVOCATE OF MATERIALISM IN NATURAL SCIENCE

The shaping and development of Lomonosov's materialist philosophy was closely bound up with the general scientific progress of his day. Since he himself was breaking new ground in nearly all branches of natural science, he had a more profound conception of the material world than many of his enlightened colleagues.

The growing requirements of industry, and primarily the needs of Russia's productive forces, were the principal factor that led scientists to tackle new problems. Industrial development, trade, and military science were making specific demands on science and at the same time preparing the material prerequisites for their satisfaction. Yet in Russia primitive, manually operated machines, were still the order of the day, and only some branches of industry, such as metallurgy, which had attained a relatively high level of development by the mid-18th century, had more modern machinery.

To meet these demands, Lomonosov strove to turn natural science into a means stimulating Russia's economic development and improving the material position of her people. He clearly realised that production of material values was still far below the required level, and that in order to achieve further and still more rapid growth of industry and other branches of the economy it was necessary to solve a constantly increasing number of scientific and technical problems.

Lomonosov was a scientist of the encyclopedist type and his brilliant knowledge of mechanics, mathematics, mineralogy, geology, metallurgy and other sciences enabled him more accurately and thoroughly than many other scientists of his day to define the tasks confronting scientific research and to draw up a plan for their realisation.

Widely read in Western philosophy, past and present, Lomonosov considered it impossible to judge of the state of science at any given period without first studying its history. Condemning dogmatism and blind admiration for the scientists of the past, Lomonosov stressed the need for creative study of the history of science and an ability to perceive the progressive trends in human thinking. "What a multitude of inventions," he wrote, "have been made by European scientists and how many useful books they have written."* Great strides were being made not only in philosophy but in various branches of natural science and Lomonosov kept track of them all. The following is a general observation which he made concerning the development of natural science in the preceding two centuries: "This little book (Wolff's *Experimental Physics*—*G. V.*) describes the astonishing discoveries made by Malpighi, Boyle, Guericke, Tschirnhausen and others after conducting interesting and diligent investigations of unforeseen natural phenomena. It is hardly possible fully to appraise the extent to which astronomy has been enriched by Kepler, Galileo, Huygens, de La Hire and the great Newton whose searching observations and analytical reasoning within a relatively brief span of time led to the discovery of such a great number of heavenly bodies that were Hipparchus and Ptolemy alive to read their books they would find it difficult to recognise the sky at which they gazed so frequently during their lifetime. Pythagoras after originating one geometric rule sacrificed 100 oxen to Zeus. But if all the contemporary mathematicians who had discovered mathematical laws were to show such superstitious zeal and follow his example, there would hardly be enough cattle in the world to go round. In a word, the speed with which modern sciences have developed would have transcended the imagination not only of people who lived a thousand years ago, but even of those who were alive a hundred years ago."*

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* M. V. Lomonosov, *Complete Works*, Vol. 1, pp. 423-24.

It was his habit before taking up any new problem, to make a careful study of what had gone before. His work on the problem of light and colours, for example, opens with a description of all the important discoveries in this field made by Descartes, Gassendi, Newton and other great scientists. Then, after thoroughly considering all their propositions on the origin of light, he accepts some and rejects others obsolete and scientifically unfounded.

Lomonosov traces the continuity in the development of human knowledge about nature over the course of many centuries. He points out that this continuity is characterised by two aspects: first, recognition of the fact that our knowledge of nature is being constantly augmented, and, second, that it is necessary steadfastly to enrich all branches of science. Analysing the development of astronomy, he writes: "From time immemorial there were gifted men who devoted their lives to astronomical studies, and not, as I imagine, for the sake of personal benefit, but because of their love for them. The fruits of their endeavours and conscientious work are now recognised by the scientific world, which is putting them to good use, and, never forgetting the great skill of our predecessors, is striving to enrich the knowledge of our successors in posterity, whose words of gratitude I can clearly hear already".** But whatever successes one or another scientist might achieve, science would never become so perfect that it could develop no further.

It was in Lomonosov's character resolutely to sweep away all obstacles standing in the path of science. He rejected scholasticism and mysticism, and distrusted the narrow, one-sided approach. In contrast to empirical scientists, he skilfully combined experimentation with theoretical generalisations, sought to arrive at far-reaching scientific conclusions and also to introduce the results of his investigations into production and the life of society.

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* Ibid., p. 424.

** Ibid., Vol. 4, p. 473.

In defiance of tradition he boldly advanced the concept that empirical data and theoretical conclusions were indivisible, and attached immense significance to laboratory experiments considering them indispensable to the successful development of science. His aim was to get to the very root of natural phenomena and the objective laws of their development. But no scientist, he maintained, should pile up experiments without offering any explanation of what they revealed. At the same time, however, he opposed scholastic theories that were not substantiated by experiment.

Tackling new problems and rejecting scientifically unproved hypotheses about phlogiston, caloric, electricity-producing fluid, etc., he sought to explain natural phenomena from strictly scientific, materialist positions.

Lomonosov's materialism in natural science reveals itself in his constant and, for his time, consistent efforts to explain the causes and substance of mechanical, physical, chemical and other natural phenomena in nature itself, and his bold rejection of anything that contradicts observations and experiments and the theories which emerged from them. In the firm belief that both the smallest, or insensible particles, as they were called then, and visible bodies could be investigated, he undertook relatively comprehensive studies of natural processes.

By the mid-18th century, the leading branches of world science were the mechanics of celestial bodies and terrestrial masses, and mathematics, especially the mathematics of constant quantities. This, in final count was due to the development of material production. *"The successive development of the separate branches of natural science,"* Engels wrote, "should be studied.—First of all, *astronomy*, which, if only on account of the seasons, was absolutely indispensable for pastoral and agricultural peoples. Astronomy can only develop with the aid of *mathematics*. Hence this also had to be tackled.—Further, at a certain stage of agriculture and in certain regions (raising of water for irrigation in Egypt), and especially with the origin of towns, big building structures and the development of handicrafts, *mechanics* also arose. This was soon needed also for *navigation* and *war*.—Moreover, it requires the aid of mathematics and so promotes the latter's development.

Thus, from the very beginning the origin and development of the sciences has been determined by production."* Lomonosov was conducting his investigations at the time when the growth of material production and the development of engineering had made it imperative to take up problems related to mechanical motion and its corresponding objective laws.

In those years particular stress was being laid on the study of specific gravity mechanics of terrestrial masses, because material production was based on primitive machines that were set in motion by the muscle power of men, or animals, by the movement of air or by falling water. The successful development of production based on such primitive machines depended on the level of knowledge of the laws and principles of mechanics. Sadi Carnot, the well-known physicist, wrote at the beginning of the 19th century: "Machines which do not receive their motion from heat, those which have for a motor the force of men or of animals, a waterfall, an air current, etc., can be studied even to their smallest detail by the mechanical theory. All cases are foreseen, all imaginable movements are referred to these general principles, firmly established, and applicable under all circumstances. This is the character of a complete theory."** Lomonosov's close study of different types of production and machines, especially of the mining and metallurgical industries in Russia and Western Europe, had shown him just what needed to be dealt with in the field of theoretical mechanics. Proof of this may be found in his book *Elements of Metallurgy and Mining* which contains a detailed description of machines, outlines many mechanical principles, and analyses the design and operation of hoists, air and water pumps, smelting furnaces and other metallurgical equipment of the time. In this work Lomonosov places especial stress on problems connected with extraction of ore and the smelting of metals; hence the detailed characterisation of various machines and their mechanical principles.

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* F. Engels, *Dialectics of Nature*, Moscow, 1966, p. 184.

** Sadi Carnot, *Reflections on the Motive Power of Fire*, New York, 1960, p. 6.

Lomonosov devoted much time to studying and improving different types of measuring instruments, apparatuses, and so forth.

In those days mechanical motion, mechanical processes and their general laws had been studied much more thoroughly than other natural phenomena and scientists tended to explain all unknown phenomena from the standpoint of mechanical principles and laws. "Among natural scientists," Engels wrote, "motion is always as a matter of course taken to mean mechanical motion, change of place. This has been handed down from the pre-chemical eighteenth century and makes a clear conception of the processes much more difficult."* The above conclusion refers primarily to the latter half of the 19th century. As regards the 18th century such a conception of nature was still historically progressive, for it gave a certain breadth to the investigation of things and natural phenomena.

Mechanical motion, Lomonosov maintained, was inherent in all substances, whether giant heavenly bodies or infinitely small particles and, consequently, mechanical theory could explain all changes engendered by motion. "Mechanics," he wrote, "is a science of motion which derives its laws from the extent, shape, inertia and position of bodies; its specific properties depend on motion, size, shape, inertia and the position of indivisible physical particles ... consequently they stem from the laws of motion and can be explained by them."**

Lomonosov based his studies of mechanical processes and motion on previously accumulated knowledge in this field. He made it his prime concern to apply the principles of mechanics to the study of chemical, physical, geological and other natural processes. Listing the requirements with which, in his opinion, all chemists should comply, he demanded that "anyone who wants to acquire a thorough knowledge of chemistry must study mechanics".*** As a genuine scientist Lomonosov was firmly convinced, as were many other progressive scientists of his day, that to get to the core of physical, chemical and other processes it was necessary to study the mechanical motion within them. Taking issue with those who rejected this basically materialist approach to nature, Lomonosov wrote: "... there are many who deny the possibility of basing chemistry on the laws of mechanics and of calling it a science. But they do so because they have lost their way in the darkness of latent properties and are unaware that the laws of mechanics always rule the changes occurring in compound substances, and also because they distrust the empty and fallacious speculations lacking preliminary experimentation which some theoreticians, who put their leisure to bad use, have imposed on the scientific world."[*] At that time Lomonosov was absolutely right in asserting that the only way of solving new problems in natural science was by carefully studying mechanical motion, the most simple form of motion that is present in all bodies and processes.

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* F. Engels, *Dialectics of Nature,* Moscow, 1966, p. 247.

** M. V. Lomonosov, *Complete Works,* Vol. 1, pp. 213, 215.

*** Ibid., p. 75.

The development of scientific thought, as Engels had proved, began with investigations of simple, elementary motion and then gradually embraced more complex forms in which elementary mechanical motion constitutes but one of their factors. Lomonosov had precisely this aspect of scientific development in mind when he wrote: "Mathematicians would have erred had they discarded simple conceptions and begun investigating difficult ones; and physicists are making a mistake by rejecting what can be seen from everyday experience and indulging in far-fetched and complicated experimentation."[**]

That such an approach to the study of inorganic nature produced valuable results may be seen also from Lomonosov's mechanical theory of heat, theory of light and colours, and theory of electricity. Mechanistic investigations of living organisms were likewise quite effective in those days. Lomonosov maintained that infinitely small particles in living organisms, and the organisms themselves, move according to the laws of mechanics. "Corpuscles," he wrote, "move in living and dead animals, in living and dead plants, and also in minerals or inorganic bodies, consequently, they move in all things."[*] Since research into the simplest mechanical processes in living organisms is essential to the development of biology, his views served to strengthen materialist principles in this branch of science.

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[*] Ibid., Vol. 1, p. 45.

[**] Ibid., p. 153.

Lomonosov advocated a close, organic relationship between mathematics and such natural sciences as chemistry and physics. He wrote: "What we need is not a mathematician who is skilled only in making elaborate calculations, but one who, having grown accustomed to mathematical exactitude in his discoveries and proofs, is able to deduce exact, unbiased facts about nature."[**]

While still living in Germany, he devoted much time to studying mathematics with a view to employing it in the investigation of mechanical, physical, chemical and other processes. In November 1740, he wrote a letter to Johann Schumacher, which stated in part: "At present I am staying incognito with friends in Marburg, where I am perfecting my knowledge of algebra, which I intend to apply to chemistry and theoretical physics."[***] Upon returning to Russia in 1741, he wrote his thesis *Elements of Mathematical Chemistry* which contains a fairly detailed study of the relationship between chemistry and mathematics.

The chemist who wants to acquire a thorough knowledge of various substances must be a good mathematician and Lomonosov did use the mathematical method, though to a limited extent, to bring to light some aspects of the relationship between these two sciences. Here, too, he was on unexplored territory. In those years mathematics and chemistry were developing quite separately and frequently contradicted one another. Instead of aiding one another in the study of nature, Lomonosov remarked, they "often lead men's minds along different paths. The chemist, seeing that every experiment produces different and often quite accidental results, and hoping to make the quickest use of them, looks upon the mathematician's reflections over exercises with points and lines as futile efforts and laughs at him. The mathematician, on the other hand, who is quite certain of his statements, for he can clearly prove them by demonstration and deduce the unknown quantity of a property through indisputable and consecutive calculation, scorns the chemist, whom he considers to be a man limited by practice and lost in a maze of disorderly experiments; besides this, the mathematician, being accustomed to a clean sheet of paper and light geometrical instruments, has an aversion to chemical smoke and ashes. And, therefore, chemistry and mathematics, these two sisters, whose purpose is the same, have usually given birth to sons of different thought, because the exact science of chemistry has not yet been united with a profound knowledge of mathematics. In spite of the fact that both sciences have made considerable progress in the current century, there are scientists who consider it impossible to combine one with the other, and have refused to study these particles with zeal and purpose, especially after observing that some people, having expended much time and effort on elaborating empty ideas and unfounded thoughts, only brought confusion to natural science rather than contributing to it."*

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[*] M. V. Lomonosov, *Complete Works*, Vol. 1, p. 159.

[**] Ibid., Vol. 2, p. 354.

[***] Ibid., Vol. 10, p. 430.

Mathematics attracted Lomonosov with its rigorous scientific concepts, logical consistency, the role played by theory in disclosing unknown quantities, etc. "Mathematicians," he wrote, "disclose unknown quantities with the help of known ones. They find the unknown quantity by adding, subtracting, multiplying, dividing, equating, converting, transferring or changing some known and unknown quantities. When applied to chemistry, which deals with countless reactions as a result of which substances are produced or converted into other substances, the mathematical method must help to ascertain the specific gravity, reciprocal arrangement and movement of minute, invisible particles which are in all compounds."** Accordingly, he frequently applied this method working on problems of chemistry, physical chemistry and physics. Suffice it to mention his *Elements of Mathematical Chemistry*, *Theory of Electricity Mathematically Explained by*

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* Ibid., Vol. 2, p. 355.

** Ibid., p. 353.

M. Lomonosov, and *On the Free Movement of Air Observed in Mines*. Commencing work on a whole series of chemical problems which he intended to solve with the help of the mathematical method, Lomonosov wrote: "In view of the fact that I shall treat of matters which I intend to explain from the standpoint of mathematics and philosophy, I consider it appropriate to preface my work with a summary of the philosophical and mathematical axioms to which I shall frequently refer. . . ."[*] Here are some of them: 1) one and the same thing cannot both exist and not exist; 2) nothing occurs without sufficient grounds; 3) one and the same thing is equal to itself; 4) a whole is the sum total of all its parts. These and other analogous thoughts provide sufficient grounds to assert that Lomonosov formulated some of the principles of mathematical logic.

But he made his greatest contribution to natural science by evolving new physical and chemical theories which helped to establish and develop materialist philosophy. He elaborated these theories on the basis of materialist atomism and on the law of the conservation of matter and motion which he had discovered.

In atomism Lomonosov followed the teachings of Democritus, Epicurus, Lucretius Carus, Pierre Gassendi, Robert Boyle, Isaac Newton and others who viewed natural science from materialist positions. He was not content with merely recognising the basic idea of the old atomistic philosophy, which held that the entire universe is composed of infinitely small elementary particles. Lomonosov sought not only to collect new data substantiating this theory, but also to produce scientific theories from it.

The universe, he asserts, is composed of solid, fluid and gaseous bodies and aether. Space is filled either with matter or aether, or both. Matter and aether are composed of elementary particles possessing specific material properties, namely, extension, shape, motion and inertia. Hence, he calls these particles bodies, and insists that since they possess all these properties they are, naturally, material bodies.

Consequently, elementary particles possess certain common properties but at the same time differ from one another, primarily in size and shape. Lomonosov maintained that the most common shape of particles is globular. But to explain the varying strength of cohesion holding elementary particles together, he advanced the hypothesis that their surface is not smooth, but as a rule has a varying degree of roughness. Atoms of air are particles of this type. It is their almost round shape, he asserts, that explains the air's relatively rapid motion which takes the form of varying rising and descending currents, etc. At the same time, to explain the friction that arises when atoms of air encounter one another, it is necessary to accept the hypothesis that their surface has also a certain roughness. In support of his idea, Lomonosov writes: "Just as nature has for its purposes thought fit to endow our globe with mountains and made its particles, even those of them that are smoothest to the touch and smallest in size, slightly rough because of certain protuberances, so, by analogy, we may draw the conclusion, that nature, skilful in its simplicity, has endowed atoms of air with minute but extremely strong protuberances for performing useful work."* This explanation of the cohesion of atoms in solid, liquid and gaseous bodies was, of course, based on the laws of mechanics, yet it was quite justifiable considering the level of natural science at the time.

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[*] M. V. Lomonosov, *Complete Works*, Vol. 1, p. 77.

Lomonosov applied the basic principles of atomism to explain the structure of aether. He believed that all bodies and phenomena in aether were composed of minute particles which also had extension, motion, inertia, a spherical shape and a rough surface. And, since outer space was not a vacuum, "particles of aether are in constant contact with each other".**

Thus, according to Lomonosov, all nature and all its bodies have an atomic structure. The essence of all phenomena, from the simplest mechanical things to complex living organisms, including man, is determined by the properties of elementary particles, their extention, shape, different forms of cohesion, etc. Outer space is filled with infinitesimal material particles of different size which, as a rule, have a spherical form with minute protuberances on their surface. Moving particles, when meeting with other similar particles, either accelerate or decelerate the movement of the latter. Their uneven surface, like the cogs of a machine, permits them to communicate motion to one another.

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* Ibid., Vol. 2, p. 115.

** Ibid., Vol. 3, p. 305.

From the standpoint of modern science Lomonosov's atomistic conceptions are rather naive, but in the mid-18th century his was the only correct approach for a scientist who adhered to materialism.

One of the most important factors which helped firmly to establish materialism in natural science was Lomonosov's law of the conservation of matter and motion. No body, he asserted, from the smallest particle to the giant heavenly orbs can turn into nothing, or appear out of nothing. The quantity of matter and motion in one or another body can increase or decrease only if there is a corresponding increase or decrease of matter and motion in other bodies.

Lomonosov quite consistently explains many natural phenomena by creatively applying the principles of atomism and the law of the conservation of matter and motion. He performed a great service in elaborating new theories in physics, chemistry, geology, astronomy, mineralogy and other sciences. His theory of the origin of heat was a milestone in the development of science in the 18th and 19th centuries. It was widely believed in the 18th century that there existed a fluid called caloric, which was supposed to produce heat. Even a prominent scientist like Christian Wolff worked on this hypothesis. Lomonosov translated into Russian an article on physics by Wolff in which the latter pointed out that since "heat is a sort of fine matter moving very rapidly" by "passing through apertures in bodies, and not only liquid bodies such as air ... aqua regia ... water or even mercury, but also solids such as metals, it tends to expand them".*

Lomonosov set out to explain the origin of heat on the basis of the properties and general laws of the bodies themselves and the infinitely small material particles composing them, and worked on this important problem for many years. In 1744, he completed the first version of his thesis on this subject, which he called *Physical Meditations on the Origin of Heat and Cold*, and read it at two meetings of the St. Petersburg Academy of Sciences on January 21 and 25, 1745. According to the minutes, Lomonosov's great discovery elicited somewhat restrained response from the academicians.

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* M. V. Lomonosov, *Complete Works*, Vol. 1, p. 466.

A totally different appraisal of this work was given by Leonhard Euler, who considered all Lomonosov's physical and chemical investigations a major advance in the development of science, and suggested that other large academies of the world embark on similar studies.

Lomonosov's thesis on heat was first published in 1750, in the first volume of the Academy's *New Commentaries*. In preparing this work for publication, he introduced some additions and alterations, but retained all the basic principles of the theory he had originally expounded. Lomonosov considered the theory of heat as his most important work and stressed this point in a resumé of his work which he called *Review of the Most Important Discoveries with Which Mikhail Lomonosov Has Sought to Enrich Natural Sciences*. In this interesting document he writes: "*New Commentaries*, Volume I of the St. Petersburg Academy has published meditations on the origin of heat and cold which prove that heat and its varying temperatures are connected with the rotational motion of matter forming all bodies and the degree to which this motion is accelerated; cold, on the other hand, is produced by the decelerating rotational motion of particles. After a priori and a posteriori investigations proving this we have obtained a clear understanding and a geometric knowledge of this fundamental natural phenomenon, which lies at the root of all other natural phenomena, and have completely disproved all vague notions about some sort of roving calorific matter."*

Lomonosov was the first in the history of natural science to advance a materialist explanation of the origin of heat by stating that it was a rotational motion of particles. Each body, he said, moves in two ways—total motion, when the whole body moves in relation to other bodies, and internal motion, which is the movement of its elementary particles. "*Heat*," he writes, "*is caused by the internal motion of matter*". But, since there was no such thing as an absolute vacuum, there were, between the elementary particles forming all bodies, whether solid, liquid, or gaseous, other particles which he called extraneous matter. "All bodies consist of two kinds of matter: *connected* matter, which moves and exerts pressure together with the whole body, and *flowing* matter, which like a river passes through the pores of the first. The question is, which of them, when brought into motion, causes heat?" Lomonosov asks, and promptly replies that "*the internal motion of connected matter in bodies is enough to cause heat*".*

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* Ibid., Vol. 10, p. 408.

As an irrefutable argument in support of this conclusion Lomonosov, even in the first version of his work on heat written in 1744, used the law of the conservation of matter and motion. "If a hot body A is in contact with a body B which is less hot," he writes, "then those particles of body A which are in direct contact with particles of body B rotate faster than the latter; therefore when reciprocal friction arises, particles of body A accelerate the rotational motion of particles of body B, in other words, they impart some of their motion to them. The former lose as much motion as is gained by the latter. And in view of the fact that the degree of heat in a body depends on the speed of the rotational motion of particles, it is clear why body A loses some of its heat in heating body B."**

Similarly, Lomonosov concludes that aether is heated as a result of the rotational motion of its infinitely small particles. The white-hot Sun imparts rapid rotational motion to particles of aether that are in contact with it, and these particles in their turn communicate motion to other particles. In this way the Sun's warmth spreads through outer space and reaches the Earth and other planets of our system.

Consequently, by creating a new theory of heat,

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* M. V. Lomonosov, *Complete Works*, Vol. 2, pp. 11, 13.

** Ibid., pp. 83, 85.

Lomonosov materialistically explained one of the most widespread phenomena occurring not only on our planet but also in the whole universe, and in doing so dealt another devastating blow against idealism and mysticism. He wrote with great conviction: "The presence of heat in bodies cannot be ascribed to a condensation of some sort of fine heat-producing matter, heat is caused by the internal rotational motion of connected matter of a heated body. Thus, we can assert that such motion and heat are inherent also in the finest matter of aether, which fills up all space between sensitive bodies, and that this matter can communicate the calorific motion received from the Sun to the Earth and other planets and heat them, and that it is the medium through which separate bodies impart heat to each other without the assistance of any perceptible substance."*

Lomonosov's new theory of the origin of light and colour constituted yet another landmark in his fight for materialism in natural science. For centuries scientists and thinkers had tried to fathom the mystery of light phenomena. They had advanced numerous hypotheses which could not, however, fully satisfy the new requirements posed by science. Further and more profound investigations into the nature of light and colour were needed, and Lomonosov boldly undertook to investigate this very difficult problem.

Lomonosov studied the works of his predecessors and made use of everything he considered important. He conducted new experiments and advanced new scientific arguments to substantiate theories and conclusions with which he agreed but which lacked sufficient proof, and improved and supplemented theoretical generalisations which were, in his opinion, one-sided and required further elaboration. At the same time he sharply criticised and rejected all outdated and scientifically unfounded ideas and theories.

Lomonosov believed that the views of ancient philosophers on light were so obsolete that there was no need to discuss them in detail. It was the theories elaborated in his day on the basis of a precise knowledge of physics that required analysis. "Of these," he wrote, "two are most important : first, the Cartesian theory, substantiated and expounded by Huygens, and, second, Gassendi's, which acquired significance after it had been accepted and interpreted by Newton. The difference between them lies in contrasting views on motion. Both are founded on some sort of fine, fluid but impalpable matter. Newton, however, says that light is a motion which flows from sources of light and spreads in all directions, like the waters of a river; the Cartesian theory describes light not as a flowing motion but as a wave movement. We must carefully consider which of these two theories gives a correct description of the nature of light and colours".[*]

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* Ibid., pp. 53, 55.

In these words Lomonosov formulated the principles underlying his approach to the extremely important question of the continuity of human knowledge in the development of natural sciences. He preferred the views of Descartes and his followers and, like Descartes, thought that light phenomena occur in the aether medium that fills all space. He also considered that Descartes' basic concepts were correct and should be used in working out a new theory on the nature of light and colours. In his work *On the Origin of Light and Colours* Lomonosov stressed: "The theory of light and the number of colours has been firmly and correctly established by these incomparable men of science, Cartesius and Mariotte. They also give a new system of elements, describe with the word 'combination' a new, hitherto unknown, property of primary elements, and assert that this combination is the cause of many natural phenomena occasioned by the motion of infinitely small corpuscles."[**]

As usual, Lomonosov based his investigations of light phenomena on materialist principles and sought to find the answer in nature herself. He was guided by materialist atomism and the law of the conservation of matter and motion.

Light phenomena, he said, existed objectively and were caused by the motion of aether particles. But since their motion might be translational, rotational, or oscillatory, it followed that one of these forms of motion produced light.

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[*] M. V. Lomonosov, *Complete Works*, Vol. 3, pp. 318-19.
[**] Ibid., Vol. 10, p. 410.

He went on to state that the heat and light phenomena present in eather differed from one another and could exist independently; therefore, they were caused by different types of motion of aether particles. "There are diverse forms of motion in aether," he writes, "some of which produce light, others fire."* Heat spreads through aether as a result of the rotational motion of aether particles, whereas light is caused by their oscillatory motion. Summing up, Lomonosov describes the spread of light through aether as follows: "Light spreads over immense distances in an imperceptible period of time (as is borne out by numerous observations and everyday experience); the oscillatory motion by means of which light spreads through aether is impossible without one corpuscle striking another; at the same time a corpuscle cannot strike another without touching it. The touch of a striking corpuscle may be either intermittent or continuous."** He recognised the existence of three types of motion in aether, but at the same time advanced the hypothesis that aether was made up of three groups of particles having a common spherical form but differing from each other in size. In his opinion particles making up the first group were the biggest. Particles of the second group were smaller and filled up the space between the particles of the first group. And, finally, the third group consisted of the smallest particles, which filled up the space between the particles of the first and second groups. On the basis of this assumption he provided a more reasonable explanation of the heat, light and electric phenomena occurring in a common aether medium, and built up his theory of combination of particles. "Particles of a specific group," he wrote, "combine with each other, but do not combine with particles of the other two groups; thus, a rotating particle of any one group as a result of cohesion with others of its kind communicates motion to a great many particles. At the same time, however, particles of the other two groups are not included in this motion. In other words, two groups of particles may be immobile, while one group is in rotational motion, and vice versa; it is also possible for all three groups to be in motion, or to remain immobile independently of each other."[*] Without resorting to non-material factors, but just by recognising the existence of three groups of particles, Lomonosov endeavoured to explain the origin of three basic colours—red, yellow and blue—and, through them, all the other colours. "The first group of aether particles," he wrote, "produces the red colour, the second—yellow, and the third—blue; all the other colours are a combination of the three basic ones."[**]

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* Ibid., Vol. 3, p. 289.

** Ibid., p. 309.

He made a noteworthy effort to explain the origin of different colours in surrounding bodies. All bodies, whether solid, liquid or gaseous, he pointed out, have three simplest forms or elements of matter, namely, "hydrochloric, sulphurous, or mercurial matter", whose interaction with the three groups of aether particles produces various colours in bodies. "As a result of long years of conjecturing which were followed by convincing experimentation," he wrote, "I have come to the conclusion that the three groups of aether particles interact with three types of elementary matter forming sensitive bodies: the biggest aether particles interact with the hydrochloric element, the second biggest with the mercurial element, and the third biggest with the sulphurous, or combustible, elementary matter...."[***]

Such are the principal aspects of his theory of light and colours. If we examine it from the heights of modern science, we find it rather naive and lacking in scientific argumentation. An adequate appraisal of Lomonosov's works on light and colours from the standpoint of our knowledge of physics was made by Academician S. Vavilov.[****] But, considering the level of science in the 18th century, Lomonosov's materialist explanation of such involved but widespread natural phenomena as light and colours was an important step forward in the search for a correct explanation of their origin.

Lomonosov's views on electric phenomena are closely bound up with his theories of heat and light. In the middle of the 18th century scientists investigating the nature of electricity were firmly convinced that there existed some sort of electric fluid. This opinion had formed as a result of their poor knowledge of electric phenomena. Even Christian Wolff, in a paper on physics which Lomonosov translated into Russian, makes virtually no mention of electricity. In a special addendum to Wolff's paper Lomonosov pointed out that "at the time when Mr. Wolff wrote his physics, very little was known about electricity, which began to attract the attention of the scientific world only around 1740."*

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[*] M. V. Lomonosov, *Complete Works*, Vol. 3, pp. 331-32.

[**] Ibid., p. 332.

[***] Ibid.

[****] See S. Vavilov, *Collected Works* (Russ. ed.), Vol. III, U.S.S.R. Academy of Sciences Publishing House, Moscow, 1956.

Investigating the origin of electric phenomena, he proceeded from his materialist positions. He completely rejected the alleged existence of an electric fluid and argued that electricity was a materialist phenomenon caused by the motion of aether particles. "Electricity," he wrote, "is an effect caused by slight friction in sensitive bodies and consists of repellent and attracting forces and the ability to produce light and fire."** Simultaneously he noted that friction should not be regarded as the only source of electricity. "We shall not explain how electricity is developed in bodies," he wrote, "and what means and machines are needed to produce it, but confine ourselves to matters directly related to our problem. We do not intend to elaborate the complete theory of electricity; our aim is to expound everything that will help us to design and substantiate the genuine theory of electricity...."***

The level of physics in those years prevented Lomonosov from creating a scientific theory of electricity, but his investigations and theoretical generalisations on the subject constituted an important stage in discovering the origin of electricity. Attraction, repulsion, light and other properties of electricity, according to Lomonosov, are caused solely by the motion of the particles of the material medium which transmits these properties. "Electric phenomena—attraction, repulsion, light and fire—are motion. Motion cannot arise without another moving body. But bodies situated at a distance from electrified bodies are not in contact with the latter. Hence, there must exist an insensitive fluid matter which surrounds an electrified body and, transformed by its force, produces this sort of action."[*] By the term "insensitive fluid matter" Lomonosov means aether. Since electric phenomena are observed in a vacuum, he reached the conclusion that they were caused by the motion of aether particles. Explaining the nature of heat and light as the result of various forms of motion of aether particles, Lomonosov refers to this concept only in general and suppositional terms when speaking of the origin of electricity. It is quite probable, he stresses, that electric matter is identical with aether. "To prove this," he writes, "it is necessary to study the nature of aether; should it be such as satisfactorily to explain the nature of electric phenomena we shall have sufficient grounds to say that electricity is caused by the motion of aether. Finally, if no other matter is found then there is every reason to be absolutely sure of the above conclusion".[**]

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* M. V. Lomonosov, *Complete Works*, Vol. 3, p. 438.

** Ibid., p. 269.

*** Ibid., p. 271.

The chief trend of all these conjectures and conclusions about the origin of electricity reflects, in the first place, his desire to provide a materialist explanation of this phenomenon, and, secondly, to show that it is organically connected with heat, light and other natural phenomena. This is confirmed by his *Report on the Phenomena of the Air Occasioned by Electric Power*, which is a brilliant effort to ascertain the peculiarities of atmospheric electricity and its connection with the motion of air. The difference in pressure and temperature of the lower and upper layers of the atmosphere produces ascending and descending air currents. Lomonosov describes these processes in the following words: "... ascending and descending air streams originate whenever the weight of the upper atmosphere exceeds the weight of its lower layers. Moreover, the lower air must clash with the upper at various heights and moves at different speed depending on the height and the difference in temperature and density. Finally, this takes place more often on hot summer days, when the heated

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[*] M. V. Lomonosov, *Complete Works*, Vol. 3, p. 283.

[**] Ibid., p. 285.

Earth warms the air above it, causing it to expand, while fierce cold still grips the middle atmosphere above the clouds."* The ascending and descending air currents originate atmospheric electricity which is manifested during thunderstorms. Lomonosov believed that by following this line of reasoning it would be possible not only to ascertain the origin and the general laws of electric phenomena in the atmosphere, but to use electric power for the benefit of the people. He entertained some excellent ideas about using electricity for the benefit of society, and drew up a plan of investigations in this field, which he outlined in his unfinished *Theory of Electricity Mathematically Expounded*. This plan included the following points; "on the development of primary electricity", "on the development of industrial electricity", "on future achievements in the science of electricity". Subsequent investigations and the application of electric power in industry showed that many of his conjectures were correct.

Lomonosov's works on chemistry, geology and mining played an important part in building up a materialist understanding of the natural sciences. In these fields, too, he displayed a materialist tendency to explain natural phenomena on the basis of nature itself and its general laws. It is mirrored in his precise, specific definition of the subject matter and goals of a whole series of natural sciences, particularly chemistry, physical chemistry and metallurgy.

An important factor which helped Lomonosov to cope with this extremely difficult task was his deep knowledge of these sciences. Speaking of chemistry as an exact science, he hastens to assert that it treats of properties and changes in bodies. Further on, he stresses that research into chemical phenomena pursues two goals: first, development and enrichment of man's knowledge of nature and the laws governing these phenomena, and, second, the practical application of chemistry. For chemists, he writes, the discovery of the exact nature of chemical substances and phenomena "is the best way to develop and improve that which they so eagerly seek to attain". Unfortunately many scientists refused to follow this line, considering it less fruitful than others. "There have been scientists in this century," Lomonosov writes, "who did set out along this difficult path and made commendable efforts to explore the close-locked secrets of substances and to kindle a light in the midst of all this darkness. But having failed in their expectations they, apparently, deprived others of almost all hope of success. We, too, would not have ventured along this road if we had not considered that by reasoning we could overcome all difficulties, and that by adhering to the strict laws of geometry and applying our knowledge of innumerable phenomena we would, in the long run, negotiate all the twists and turns and beat a path to the great light of a new and sound philosophy."*

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* Ibid., p. 45.

A good knowledge of mechanical, physical and chemical phenomena also enabled Lomonosov to give a materialist definition of the subject matter of physical chemistry and metallurgy.

Defining the substance and the goals of chemistry, Lomonosov, as in other branches of knowledge, stresses its principal traits and draws a clear line between one science and all the others. He tolerated no uncertainty in choosing objects for investigation.

He clearly defines his attitude to this question in his approach to metallurgy as a science. In the preface to *Elements of Metallurgy and Mining*, he warns against unfounded extension of the goals facing the science of metallurgy. "Metallurgy", he writes, "is nothing else but a good knowledge of the use of metals. But this science would be practically limitless were it also to include descriptions of all known processes of preparing metals for use. No one would doubt this were he to picture in his mind's eye all the trades, professions and handicrafts which employ iron alone. I speak of this so as to draw a line between pure metallurgy and other occupations which profit by it; for example, at iron factories there are ordinance works and smithies, at copper factories—boiler-making and similar trades not directly related to metallurgy, because it fulfils its purpose by producing pure and nonmalleable metals ready to be made into all sorts of commodities.

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* M. V. Lomonosov, *Complete Works*, Vol. 3, pp. 459, 461.

Hence, a writer who gives a detailed description of these trades will be doing more than is required of him."*

Lomonosov was among the first scientists who in addition to clearly defining the range of problems which chemistry should embrace also practically demonstrated the way to tackle them.

He personally investigated chemical processes in a laboratory built under his supervision. In the middle of the 18th century chemistry had not yet become an independent science and all knowledge accumulated by chemists over the centuries had to be subjected to very critical study. At that time almost all chemists based their research on the unscientific phlogiston hypothesis, and it was no accident that Lomonosov, who was bent on testing the accuracy of various hypotheses and many experiments carried out by scientists before him, persistently demanded the establishment of a chemical laboratory. He used to say, and quite justifiably, too, that the "Academy of Sciences can clearly see that the absence of a chemical laboratory deprives it of an extremely efficient and necessary means for investigating nature and putting an end to spurious discoveries".**

He drew up a specific plan of chemical research, which was all the more necessary, considering that chemistry was only beginning to develop into a science, and the first chemical laboratories were just being established.

"I shall base my chemical investigations on the following points: 1. Natural substances used in a chemical experiment should first be properly cleansed of any foreign matter, lest any error occurs in the course of the experiment. 2. Cleansed substances must be broken down as far as possible into the natural elements out of which they are formed. 3. To clearly prove that decomposed substances really consist of the elements obtained, they should be synthesised again and again. 4. Various natural and synthesised substances should be chemically combined to obtain new processes and compounds which may be used to further our knowledge of nature and increasing experience. 5. To corroborate by means of identical experiments all discoveries made by chemists, which appear quite plausible but at the same time cause certain doubts and are not described in detail.... In all the above experiments I shall observe and register not only actions, weights and volumes of substances and vessels employed, but also any accompanying phenomena that may become manifest...."[*]

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* Ibid., Vol. 5, p. 393.

** Ibid., Vol. 9, p. 15.

Lomonosov applies the fundamental principles of atomism to explain chemical phenomena and to formulate some of the basic rules of this new branch of natural science. He is legitimately considered one of the founders of atomic theory. In one of his early works *Elements of Mathematical Chemistry*, he offers a materialist definition of atoms and molecules. The atom, or element, as Lomonosov calls it, "forms a part of a body and does not consist of other smaller or different bodies". Chemical substances, he asserts, owe their diversity to atoms or elements. There are homogeneous and heterogeneous bodies composed of molecules or corpuscles. The latter are separate bodies made up of atoms. Molecules, or corpuscles are formed from homogeneous or heterogeneous atoms. "Corpuscles," he writes, "are homogeneous if they consist of an equal number of homogeneous elements which are linked to each other in a similar manner. The existence of such corpuscles is proved by the homogeneity of the mass of a body, all of whose parts are like the whole." He attributes the infinite diversity of bodies to atoms, both homogeneous and heterogeneous, which cluster in different numbers and arrangements into molecules.

With this understanding of atoms and molecules as his starting point, Lomonosov also describes the nature of chemical elements. By an element he means a chemical body consisting of homogeneous molecules or corpuscles. Elements, or first-beginnings as he calls them, form compound chemical substances.

Studying chemical substances and phenomena, he applied the law of the conservation of matter and rejected the phlogiston hypothesis.

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[*] M. V. Lomonosov, *Complete Works*, Vol. 9, pp. 16-20.

Lomonosov drew on mechanics, physics, chemistry, geology and other natural sciences to explain involved natural phenomena. But when this method proved inadequate he went further and called for the creation of new branches of science. And he did elaborate some fundamental principles of the new science of physical chemistry. Studying bodies consisting of various substances, or compound substances, to use the scientific terminology of those days, he realised that a mere combination of physical and chemical methods of research would limit the scope of his investigations and that both branches of science had to be combined into a single branch of knowledge.

He defined the subject matter of physical chemistry in the following words: "Physical chemistry is a science which explains on the grounds of physical experiments and laws the processes taking place in compound substances under chemical reactions."* He also considered it necessary to determine the place and role of physical chemistry in the life of society. It is imperative, he stressed, that "a person after diligently studying chemistry and acquiring a good knowledge of compound substances should be fully capable of using it for the benefit of society."**

Besides, defining the goals of physical chemistry, he described the methods by which he intended to attain them. On May 11, 1752, he presented a report *On Physical Experiments to Be Included in the Course of Experimental Chemistry* to the Academy of Sciences, in which he wrote: "I shall work on the following problems:

"1. determine the specific weight of chemical substances;

"2. investigate the cohesion of their particles by means of:

"a) fracture,

"b) compression,

"c) grinding on stone,

"d) counting the drops of liquid substances;

"3. describe the configuration of crystallising bodies;

"4. register the temperature in all experiments;

"5. study the effect on substances of prolonged rubbing, particularly metals.

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* Ibid., Vol. 2, p. 483.

** Ibid., p. 485.

"In short, I shall endeavour to study everything that can be measured, weighed and defined with the help of practical mathematics."*

He was particularly interested in studying the effect of heat on the cohesion of particles in compound substances. The latter have many physical and chemical properties and in order to study them correctly he considered it necessary first to determine their chief features on the basis of the atomic theory. "A compound substance," he wrote, "consists of two or more heterogeneous bodies which are linked in such a way that any sensitive part of this compound is exactly the same as any other as regards its specific properties. Gunpowder, for example, consists of potassium nitrate, sulphur and charcoal, which are heterogeneous bodies, and any one sensitive part of it has exactly the same colour, cohesion of particles, explosive force, etc., as any other. Bodies forming compound substances, in this case potassium nitrate, sulphur and charcoal, are called components."**

He remained loyal to materialist positions in investigating compound substances, that is, he sought to explain their origin by proceeding from the general law of development of natural substances themselves and had no use for the non-scientific, mystical approach, which, as he put it, "hides not only explanations but also methods of investigation."*** He considered that the best method of studying a compound substance was to investigate its minutest particles and the particles of its components. A compound substance, he reasoned, say gunpowder, consists of infinitely small physical particles possessing identical properties and manner of arrangement. This is proved by the fact that all parts of a compound substance, irrespective of size, possess the same properties. But this does not adequately explain the origin of compound substances. It is necessary, therefore, to study the more elementary bodies and the infinitely small particles, of which a compound substance is formed. Only after studying these elementary bodies and their particles and the manner in which the latter are arranged will it be possible to explain the origin of a compound substance, say gunpowder, and to make it in a laboratory or at a factory.

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* M. V. Lomonosov, *Complete Works*, Vol. 9, pp. 56-57.

** Ibid., Vol. 2, p. 487.

*** Ibid., p. 483.

Lomonosov gave grounds for investigating compound substances and arrived at the following conclusion: "Having determined the properties of a compound substance by experimentation, we see that combinations of different bodies produce various substances and phenomena; hence, to obtain information about the individual properties of bodies and the changes taking place in them, it is essential to know their components. It follows, therefore, that chemistry must investigate both the composition of sensitive bodies and the elements, or 'origins' of compound substances."[*]

The latter, according to Lomonosov, owe their properties to the manner in which their particles are linked with each other. Should the manner in which they are linked change, so will the properties of a compound change.

Moreover, a change in the properties of a compound substance occurs as a result of a change in the composition of its particles which arises when a corpuscle either loses or acquires one or more elements. But this cannot take place without a change in the way particles are linked, therefore, there have to be causes which can destroy this connection. Lomonosov was sure that these causes lay in nature itself. One of them in his opinion was heat, or fire. "The extent to which varying degrees of heat produce changes in the cohesion of particles," he wrote, "is clearly demonstrated by the melting of solid bodies...."[**]

In the course of several years a huge number of experiments in physical chemistry to verify the basic theoretical principles of this new field of knowledge were conducted by Lomonosov personally, or under his direct supervision.

Lomonosov's works on geology played a significant role in promoting a materialist understanding of natural science. He advanced a scientific, materialist explanation of many involved geological processes occurring both on the surface of the Earth and in its depths, and he is legitimately considered the founder of the science of geology. He explained the causes of earthquakes and volcanic eruptions, the origin of metals and minerals, and the formation of mountains on the basis of the general laws of nature. A comprehensive scientific analysis of this aspect of Lomonosov's creative activity has been given by D. Gordeyev in his book *M. V. Lomonosov—Founder of the Science of Geology* (Moscow University Publishers, Moscow, 1961).

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[*] Ibid., p. 489.

[**] Ibid., Vol. 2, p. 575.

In the mid-18th century, geology as a science virtually did not exist. Engels, in his *Dialectics of Nature* points out that it began to take shape only at the close of the 18th century.[*] Prior to Lomonosov, people harboured the most fantastic notions about the origin and development of the Earth. But scientists were accumulating concrete data, studying minerals, and describing volcanic eruptions, earthquakes and other geological phenomena.

Lomonosov was the first to formulate the theoretical scientific propositions that provided the foundation of geology as a science. His explanations of various geological phenomena, unlike those of many scientists, rested on a knowledge of mechanics, physics, astronomy, metallurgy and other sciences. Important conclusions regarding the changes that had been taking place and are still occurring on our planet could be drawn only by such a comprehensive study of geological processes. Lomonosov pointed out that a study of rocks and other geological objects requires the application of "precise sciences, particularly the mechanics of solids and fluids, when measuring forces operating in nature, metallurgical chemistry, when separating the minerals comprising the Earth's layers, and general geometry, without which theoretical investigations are impossible."[**]

Specifying the basic principles of geology as a science, he stressed the following points: first, it should be recognised that our planet, its surface and the bowels of the Earth are undergoing incessant changes. "Frequent changes taking place under the Sun," he wrote, "prove that the Earth's surface today is altogether different from what it was in ancient times. For it often happens that high mountains fall apart from the Earth's tremors and plunge into broad cavities which are then filled up with artesian water spouting from the depths of the Earth or with sea water. And, contrariwise, new mountains rise on flat land and parts of the sea bed rise to form new islands. From the works of ancient writers and from recent examples we can see that nature has been acting in this way in all ages."*

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[*] See F. Engels, *Dialectics of Nature*, Moscow, 1966, p. 185.

[**] M. V. Lomonosov, *Complete Works*, Vol. 5, p. 574.

Second, we should proceed from the fact that changes in rock structure are always accompanied by the transformation of simple substances into more complex ones, etc. According to Lomonosov, "minerals are the simpler the closer they are to the elements forming the Earth, and the more complex the farther they are from them"; hence, in investigating "the layers of the Earth it should be carefully ascertained whether they are primordial or whether they were formed at a later period".**

Lomonosov deserves credit for being the first among scientists to regard geological phenomena not only in the process of development but as something forming a single whole. In 1911, the prominent scientist Academician V. Vernadsky wrote in an article entitled *A Few Words About Lomonosov's Works on Mineralogy and Geology:* "Lomonosov was justified in introducing into scientific research the method of understanding and studying natural processes which was later taken up by Pallas, de Saussure and William Smith and won its place in science in the 19th century through the works of Carl Hoff and Charles Lyell—the method of the unity of geological processes of accumulation in time of the phenomena now taking place in the Earth's crust. Lomonosov's lucid and vivid description of this idea in his *On the Layers of the Earth* is indeed extraordinary for the 18th century."***

Not content with merely describing geological phenomena, Lomonosov wanted scientists to work on concrete problems whose solution would stimulate the country's economy. To further the development of industry, agriculture and trade in Russia it was imperative to make a thorough study of her mineral wealth. Here, too, Lomonosov played an outstanding role. Many of his works, especially *On the Layers of the Earth*, *On the Earthquake Origin of Metals*, *Elements of Metallurgy* and others, not only contained excellent theoretical generalisations of observations and investigations of methods for discovering mineral wealth in Russia and other countries but were also the best manuals describing how further studies of the depths of the Earth should be conducted. In this way he was formulating the basic principles of the special science of metallurgy and mining which, as he put it, "teaches how to distinguish and discover minerals and to dress them so that they will be useful for society".*

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* Ibid., p. 300.

** Ibid., p. 575.

*** *Lomonosov's Works in the Field of Natural Sciences* (Russ. ed.), St. Petersburg, 1911, p. 147.

Extensive personal observations and comprehensive theoretical investigations led Lomonosov to the conclusion that Russia had a wealth of useful minerals. In 1761, he submitted a document to the Senate dealing with "the collecting of samples of minerals in all parts of the country" in which he wrote: "It is quite obvious that the vast Russian state has a wealth of useful minerals. Ordinary curiosity should make people study the depths of the Earth and then enrich science by presenting their description of them to the scientific world. There is no doubt that such an enormous territory has many unprospected deposits of ores, metals and valuable stones. Take for instance Siberia, Olonets, or Medvezhy Island where ores have been accidentally discovered, thus proving that similar or even better deposits, which could increase the wealth, might and glory of the country, remain hidden because we have no knowledge of the natural history of minerals."**

Lomonosov was firmly convinced that there was just as much natural wealth in Russia's northern regions as in countries with a hot climate, and urged extensive prospecting for useful minerals. He was confident that the Russian and other peoples of the country would make great headway in this direction. "Hot countries," he wrote, "have an advantage over us not because they are richer in metals than we are, but because extraction is easier there. But the Northern people have a greater ability for work than the people living in the hot zone, and this fact should bring its reward. Russia is vast and rich. Therefore prospecting for metals requires persistence and hard work. It seems to me that I can hear her summoning her sons: Believe in me, plunge your hands into my bosom and have no fear that your search will be futile. My fields reward the hardworking farmer, my rich meadows multiply your cattle and my forests and rivers abound in animals, so that you will not go hungry; I satisfy not only all your needs, but even give of my wealth to other countries. Then how can you think that my mountains will not reward the sweat of your brow with vast treasures. In all my lands, which stretch from hot India to the shores of the Arctic Ocean, there are numerous signs of my mineral wealth. To help you search for them in the summer I thaw the ice on the great rivers, and in winter cover the Earth with a smooth blanket of snow. I expect that your efforts in prospecting will augment trade and develop industries, that they will help beautify our towns and strengthen and multiply our troops; I expect and want to see a great fleet that will throw the enemy into fright, sailing my vast seas."*

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* M. V. Lomonosov, *Complete Works*, Vol. 5, p. 367.

** Ibid., p. 351.

It was clear that such as immense and complicated problem could not be solved by a small group of scientists and mining specialists. Lomonosov saw three ways of organising mineral prospecting. First, by inviting a large number of foreign experts, second, by training many Russian specialists without sending them abroad, and, third, by drawing broad sections of the local population, including children of school age, into prospecting work. The first two would have required big financial outlays and much time. So, Lomonosov suggested that the Senate should authorise local officials to enlist the help of citizens of small towns, especially children, to collect samples of rocks and to send the most interesting ones to the Academy of Sciences in St. Petersburg.

After studying these samples the Academy should send specially trained people to ascertain on the spot whether the extraction of minerals or metals there would be a worthwhile proposition. He wrote that should the Senate approve his project, he would undertake "within a year to teach mineralogy and chemical analysis to as many gifted young men possessing a knowledge of arithmetic and geometry as the Senate should consider necessary. . . ."*

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* Ibid., Vol. 2, pp. 361-62.

He was not to blame that his far-sighted plans to organise large-scale study of Russia's immense mineral wealth were not supported by the ruling classes and therefore did not see the light of day. It was only in socialist society that his plans were carried out and on a scale that would have astounded him. S. Kirov, a prominent Party worker, once told Soviet scientists: "Lomonosov already in his time called us to the North to see what was going on there. This far-sighted man, who lived 200 years ago, wrote with pain: 'Many proofs lead me to the conclusion that in the cold north, too, there is abundant mineral wealth, but there is no one to seek this treasure.' And added that 'metals and minerals will not come to us on their own. Eyes and hands are needed to discover them.' I think that all our scientific organisations, beginning with the Academy of Sciences, and all practical workers should follow Lomonosov's advice and really use their eyes and hands to find out what that rich and huge region has to offer."**

Lomonosov also elaborated some important problems of soil formation, elevating them to the level of soil science. But in the 18th century this branch of knowledge did not exist, so it is all the more amazing that his theoretical propositions gave a basically correct, scientific explanation of the origin of *chernozem* (black earth—*Ed.*) and other related soil formations. He arrived at the conclusion that black earth was not of mineral origin, but appeared as a result of the influence of vegetable and animal organisms on the surface layer of the Earth. "Black earth," he wrote, "is found mostly in birch and other forests whose trees shed their leaves in autumn. As is known fallen leaves decay and turn into manure, so it is only natural that the thicker and higher the forest the more black earth overlies sand, clay and other layers."*

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* M. V. Lomonosov, *Complete Works*, Vol. 5, p. 355.

** S. Kirov, *Selected Articles and Speeches* (Russ. ed.), State Publishing House of Political Literature, Leningrad, 1939, p. 475.

Similarly, he describes the influence of meadow grasses on soil. The remains of vegetable organisms decompose after coming into contact with the Earth and turn it into black earth. This is how he describes this process: "Almost all mosses grow on black earth. But what is its origin? Perhaps the lands now covered with mosses were once overgrown with great forests which were uprooted by storms or floods and fell into decay becoming a food for moss, which grows not only on fallen trees but also on all species of standing ones. Even bare mountains are frequently covered with green patches of young moss and other herbs which turn into peat and then into earth; after many years the soil gives birth to larger species of moss and other herbs. Moss, we know, grows not only in the summer, but also in the winter under the snow, so it is no wonder that this herb with its small roots sometimes grows to a height exceeding that of the melilot. It is also very probable that it decays at the bottom and forms black earth".**

This explanation of the formation of black earth and other soils was a major scientific achievement for the 18th century. His basic theoretical premises concerning the origin of black earth were subsequently confirmed by natural science, particularly in the second half of the 19th and the beginning of the 20th century, when the distinguished Russian scientists V. Dokuchayev and P. Kostychev and later V. Williams pioneered the new branch of knowledge called soil science. They proved that soil is a natural body which appeared and developed as a result of the interaction of such material factors as the surface of the Earth, initially composed of inorganic rock, the climate, vegetable and animal organisms and so forth.

Lomonosov's views on the formation of black earth, which he set forth in general outline, were scientifically elaborated in the works of prominent Russian soil scientists.

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* M. V. Lomonosov, *Complete Works*, Vol. 5, p. 589.

** Ibid., p. 590.

V. Williams describes the formation of soils in the following words: "Soil formation is a process of the action of biological factors on the product of rock weathering—parent rock—and consists of two elements, which are both equally important and which are identical in all parts of the world: the process of the formation of organic matter and the process of the decomposition of this matter; the constantly and regularly changing combination of these two inseparable elements of the soil-formation process with just as constantly and regularly changing geological processes, the climate of a country, its relief and the properties of the parent rock produce a closed chain of various evolutionary stages of soil formations and a continuous succession of their morphological features."*

Lomonosov examined the formation of black earth and other changes in the soil in connection with various geological, physical, chemical, climatic and other phenomena. The same idea, but more thoroughly elaborated, may be found in the generalisations of Dokuchayev, Kostychev and Williams. When Dokuchayev, as an old man, came across Lomonosov's idea, he frankly declared that the theory which brought him his Doctor's degree had been expounded long before in Lomonosov's works.

While investigating geological and other inorganic processes, Lomonosov also meditated on some biological problems. He did not make this branch of knowledge the object of special research, but, being an encyclopedist, he considered it important to shed light on some aspects of the interdependence of inorganic matter and living organisms. He came face to face with this problem when seeking an explanation for the presence of the remains of vegetable and living organisms in rocks, and the origin of coal, oil, black earth and so forth.

Special note should be made of his fruitful efforts to prove that living organisms are also subject to physical and chemical laws. "Although animal and vegetable organs are very cunningly constructed," he maintained, "they, nevertheless, consist of still smaller, inorganic particles, namely compound substances, because chemical action destroys their organic structure and they become compound substances. Thus, all compounds obtained from animal or vegetable matter either by nature herself, or artificially, are also chemical matter. Hence, we can clearly see that the laws of chemistry are effective in all bodies. . . ."*

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* V. Williams, *Collected Works* (Russ. ed.), Vol. 2, Moscow, 1948, p. 381.

Besides advancing proof that inorganic matter and living organisms have a common material foundation in the form of atoms and corpuscles and that they are subject to the law of the conservation of matter and motion and other laws, he endeavoured to describe certain qualitative peculiarities of living organisms stressing their more involved structure, metabolism, etc.

He unfolded a well-argumented idea concerning the nutritive mechanism of plants, according to which plants absorb nutrient substances from the soil through their system of roots while the leafage of deciduous and evergreen trees absorbs food from the air. This is how he describes the process: "There is no need to search for the source of the new life-giving sap in a pine, for we know that through the imperceptible pores in its numerous needles it sucks in the nutrient moisture which spreads through the whole of the tree and becomes its food and body. Therefore, it is wrong to imagine that the old fallen needles return to the pine through its roots, whose principle function is to keep the tree firmly embedded in the soil rather than to provide it with food, although they also help promote its growth."** Voicing this brilliant idea Lomonosov sought to provide a scientific, materialist explanation for the presence of immense quantities or organic matter on the Earth's surface, and to show that coal, oil and some other combustible minerals were of organic origin. If plants feed on soil alone, they should take from it as much matter as they return to it. But then the Earth could never have accumulated such a huge amount of organic matter. If, on the other hand, plants absorb nutrients from the air and only partially from the soil, then the origin of this enormous quantity of organic substances can be attributed to natural causes. The basic thoughts underlying this remarkable concept were subsequently verified in the works of many scientists, particularly in Timiryazev's classic works on the physiology of plants.

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* M. V. Lomonosov, *Complete Works*, Vol. 2, p. 555.

** Ibid., Vol. 5, p. 590.

An analysis of Lomonosov's natural scientific generalisations and theories shows how boldly and vigorously he championed a materialist explanation of the ingenious and manifold natural phenomena, never attributing them to acts of Providence and so forth. When he does occasionally speak of divine forces he is merely keeping in step with the times and is far from defending idealistic, religious views on nature. His scientific theories were a firm foundation for his materialist philosophy.

Chapter IV

MATTER AND ITS PROPERTIES

Lomonosov played a prominent role in substantiating and developing materialist philosophy. Investigations of his works by Soviet scientists yielded sufficient proof of his unconditional adherence to materialist positions. Characterising one of the most important aspects of 17th-18th-century materialism, Engels wrote: "It is to the highest credit of the philosophy of the time that it did not let itself be led astray by the restricted state of contemporary natural knowledge, and that—from Spinoza down to the great French materialists—it insisted on explaining the world from the world itself and left the justification in detail to the natural science of the future."* This in full measure applies to Lomonosov. Moreover, he belonged to that group of materialists who were not content with giving a general philosophical explanation of the world, but by their great discoveries and scientific generalisations contributed much to a detailed substantiation of this explanation.

We have already said that Lomonosov searched for the causes of the changes taking place in social processes in the processes themselves, and mentioned God just because it was customary to do so at the time.

As regards natural phenomena, he consciously and quite consistently for those days, explained them on the basis of internal material factors and objective laws. Materialist philosophers of the pre-Marxist period were materialists at the bottom, when explaining what takes place in the non-organic and organic world, and idealists at the top, when interpreting social processes. Lomonosov also belonged to this category. Although he upheld individual materialist tendencies in explaining some aspects of social life, as can be gathered from Chapter II, his positions in this field were on the whole idealist. Lenin made the following observation in his appraisal of pre-Marxist historical theories: "In the first place, the latter (the theories—*Ed.*) at best examined only the ideological motives in the historical activities of human beings, without investigating the origins of those motives, or ascertaining the objective laws governing the development of the system of social relations, or seeing the roots of these relations in the degree of development reached by material production; in the second place, the earlier theories did not embrace the activities of the *masses* of the population."* We can trace such features in Lomonosov's social and political ideas and theories.

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* F. Engels, *Dialectics of Nature*, Moscow, 1966, p. 25.

Thus, the materialist camp of the pre-Marxist period should embrace all those who viewed natural phenomena from materialist positions. But, proceeding from this general assumption, are we entitled to call any scientist who approaches natural phenomena from the materialist point of view a materialist philosopher? Obviously not, for by no means all natural scientists rose to the level of consciously mastering and applying the fundamental principles of materialist philosophy as a science. Lomonosov, however, belonged to the category of scientists who regarded materialist philosophy as a science. He carefully studied it and consciously applied its principles in one or another branch of natural science.

An examination of Lomonosov's works, the sources he drew upon, and his library provide good grounds for asserting that he had devoted much time to a searching study of both the materialists of the slave-owning society, including Democritus, Epicurus, Titus Lucretius Carus, and the materialists of the 17th-19th century—Giordano Bruno, Galileo, Descartes, Gassendi, Spinoza, Bacon, Hobbes, Locke, Newton, and many other philosophers.

Moreover, we shall show further in this book that Lomonosov not only knew many materialist systems of philosophy, applied some of their principles in his works and adduced new proof of their correctness, but that he also creatively developed them. Likewise it should be noted that he studied idealist systems, particularly the systems of such philosophers as Gottfried Wilhelm von Leibniz, in an effort critically to assimilate their rational aspects.

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* V. I. Lenin, *Collected Works*, Vol. 21, p. 56.

Lomonosov the philosopher was never a slave of any one philosophic doctrine, as we can see from his attitude to the philosophy of Aristotle.

Lomonosov was impressed by those thinkers of the 16th-17th centuries who opposed medieval scholasticism, who criticised Aristotle's philosophy and sought an independent solution to ripe scientific problems.

Galileo, who was one of the first to come out against absolutising Aristotle's teachings, urged scientists to study nature boldly, persistently and independently. Selviati, a character from Galileo's famous *Dialogue*, declares: "In saying this, I do not mean that a person should not listen to Aristotle: indeed I applaud the reading and careful study of his works, and I reproach only those who give themselves up as slaves to him in such a way as to subscribe blindly to everything he says and take it as an inviolable decree without looking for any other reasons."*

Scholastic philosophy was also scathingly criticised by Bacon, Descartes and other renowned thinkers. Lomonosov adhered to the same line. "The development of sciences, especially philosophy," he wrote, "has been impeded no less by blind adherence to the thoughts of the great, than by the dark events of the time. All those who practised philosophy followed Aristotle alone and considered his ideas infallible. I have nothing against this great and once outstanding philosopher, but it is regretful and amazing that there were people who could consider the views of one mortal man infallible thus creating the chief obstacle to the progress of philosophy and other related sciences. This tendency chilled the lofty ambitions of scientists to excel one another in making useful discoveries. The first of the new philosophers who dared to reject Aristotle's teachings and to propound his own ideas was the great Cartesius. Among other things, we are indebted to him for encouraging scientists to search for the truth by arguing against Aristotle, against himself and against other men of science, thus opening the road to untramelled philosophising and more substantial scientific progress".*

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* Galileo Galilei, *Dialogue Concerning the Two Chief World Systems—Ptolemaic and Copernican*, Berkeley and Los-Angeles, 1953, pp. 112-13.

Thus Lomonosov characterised his attitude to the old philosophic teachings and systems and those that were current in his day. His own philosophy sprang from his searching investigations into natural and social phenomena, and from independent, creative examination of preceding philosophical, particularly materialist, theories and achievements in natural sciences and culture. He cultivated and improved it while working on problems in the most diverse fields of science and culture.

In the light of these irrefutable facts it is even less sensible from the point of view of science to claim that his world outlook was derived from one particular philosophical system, let alone to regard it as a duplication, or a retelling of some idealist doctrine. Nevertheless, beginning with the second half of the 18th century right up to the present day repeated attempts have been made to dissolve his philosophical theory in various systems, most of them idealist. Investigators from the Russian nobility and the bourgeoisie who falsified Lomonosov's works followed two principal trends. The first and the most popular was to assert that Lomonosov as a philosopher was the product of the idealist philosophy of the German thinkers Gottfried Leibniz and Christian Wolff. By distorting and juggling with his philosophical premises and ideas, V. Tukalevsky, P. Sakulin, A. Preobrazhensky, I. Zamotin and other "interpreters" of Lomonosov's philosophy endeavoured to "prove" that it contained nothing original.

The other trend, which was founded by D. Galanin and other adherents of the idealist philosophy of the Slavophiles, stubbornly claimed that Lomonosov's philosophy evolved from the original Russian spirit, principally from the ideology of the Russian Orthodox Church.

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* M. V. Lomonosov, *Complete Works*, Vol. 1, p. 423.

In spite of their seemingly different positions, these two groups of historians agree on the basic issue, namely, that Lomonosov's philosophy was, first, religious and idealist, and, second, that it contained nothing original. For a critical appraisal of these conclusions let us quote the opinions of representatives of both groups.

V. Tukalevsky's book *The Principal Aspects of Lomonosov's World Outlook*, published in 1911, in connection with the bicentennial of Lomonosov's birth is a good example of how Lomonosov's philosophical views were distorted by the first group. The author, like many other investigators of Russian philosophy and culture of his type, portrays Lomonosov as a champion of idealist rationalism. "In the first half of the 18th century," he writes, "the philosophical ideals of a certain section of Russian society were founded primarily on rationalism. Peter the Great was the first open worshipper of the God of 'enlightenment', and Mikhail Lomonosov was the high priest in the temple of this God."*

Tukalevsky begins with a general tribute to Lomonosov. He calls him "a prophet of new ideas" and says that "his poetic and scientific works contain scattered thoughts and rudiments of discoveries which amaze his followers."**

But what are these new ideas? It turns out that "in his works we shall not find a philosophy based on the 'theory of cognition' ",*** that his fate was to imitate the idealists Leibniz and Wolff. Tukalevsky writes that Lomonosov's main source was the "philosophy of Leibniz which was taught to him by Christian Wolff. It has become customary to speak of Wolff's 'influence' on Lomonosov. But a more thorough examination of the philosophy of Leibniz, Wolff's theories and Lomonosov's ideas discloses that in some matters Lomonosov comes closer to Leibniz than his disciple and Lomonosov's teacher Christian Wolff. This may be gathered if only from the fact that Wolff altered the real meaning of Leibniz's 'pre-established harmony', whereas Lomonosov made this fundamental idea of the German philosopher one of the chief premises of his philosophy."*

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* V. Tukalevsky, *The Principal Aspects of Lomonosov's World Outlook (Leibniz and Lomonosov)* (Russ. ed.), St. Petersburg, 1911, p. 13.

** Ibid.

*** Ibid.

Tukalevsky tendentiously selects and interprets some of Lomonosov's utterances containing elements of deism. His principal goal is to "prove" that Lomonosov was an idealist, an adherent of Leibniz's philosophy and a champion of religion. He writes: "While recognising the impossibility of *motion* without a moving substance, Lomonosov together with Leibniz also arrives at another concept about the 'reciprocal alliance of things' or 'universal reciprocal harmony' whose substantiation requires the existence of God. Leibniz actually calls reason God. Lomonosov, however, ends his discourse in the form of a question, as though unwilling to use the word God. Lomonosov frequently uses the words God, the Lord, and deity in his works, and in one place even exclaims:

'Thou has commanded me, oh Lord,

'To praise you from my childhood days.' "** Further, the author alleges that by "God" Lomonosov means "some sort of force which has created the world and is moving the universe. This force is reasonable, almighty, generous, and so forth. Of course, it would be best to call it God. And Lomonosov frequently does so. This force, this God of Lomonosov's defies human understanding, and the only way of 'indulging' it is by striving to approach it. In what? ... In reason, of course. This force is, above all, reasonable, hence it is necessary to develop one's reason and come nearer to God by learning to understand the world and by unveiling its secrets."***

Tukalevsky also completely distorts Lomonosov's essentially materialist atomism and identifies it with Leibniz's idealist monadic theory. According to Tukalevsky Lomonosov's atomism consists in that he allegedly places a globule "at one end of the unbroken 'chain of union', and God, the force that created the first globule, at its other end. An infinite number of steps separate each stage in this chain. And each substance, each being is different, independent and created by God alone. Everything is different in the world, only the 'chain' that is formed of all these multifarious units, is one."*

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* V. Tukalevsky, *The Principal Aspects of Lomonosov's World Outlook* (*Leibniz and Lomonosov*), p. 14.

** Ibid., p. 21.

*** Ibid.

Having deprived Lomonosov's atomism of its scientific and materialist foundation, Tukalevsky seeks to "prove" that Lomonosov's views on this important question coincide with those of Leibniz. Citing the latter's premise: "And so everywhere there is life, everywhere there is spirituality, the difference is merely in its degree; in the inorganic world it is unconscious spiritual life, in animals it is sensation and memory, in people it is reason", he draws the conclusion that Lomonosov's and Leibniz's views "coincide" "first, in the very method of splitting the universe into certain particles which are set in motion by a first impulse, and second, we see that both Leibniz and Lomonosov, who are contemplating a world consisting of particles, are individualists who recognise the isolation of separate beings. But the principal thing is that both of them understand the world as space filled with life. Everything lives. Nothing is dead, but everything lives its own life. On this latter point Lomonosov's closeness to Leibniz seems particularly important to us. For this is what forms the basis of Lomonosov's conception of the world, his realisation of it, and his cognition of the creator of the universe".**

P. Sakulin in his *Individuality of Lomonosov*, published in Moscow in 1912, also frankly sustains this reactionary idea without even bothering to substantiate it with scientific arguments. In his opinion Lomonosov is but an untalented pupil of the German idealist Christian Wolff. He writes: "Lomonosov was Wolff's pupil. But whatever its shortcomings, Wolff's teaching was a complete system which laid the foundation for the systems of the great German idealists (Kant, Fichte, Schelling and Hegel). Wolff opened new perspectives to the Russian scientist of the first half of the 18th century, and we can hardly doubt that Lomonosov as a thinker owes a great deal precisely to Wolff (and maybe in some measure also to Leibniz)." Sakulin arrives at the following generalised conclusion: "Lomonosov's scientific and philosophic outlook was imbued with the same spirit as the philosophic system of the once famous *German philosopher,* who strove to reconcile logical deduction and empiricism, religion and knowledge. . . ."*

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* Ibid., p. 24.

** Ibid., p. 25.

Sakulin thought nothing of calling Lomonosov's outlook scientific and philosophic and at the same time declaring that it contained nothing new or original from the scientific point of view. Like all other apologists of the landowner-bourgeois ideology, he had to resort to unscientific methods to render harmless Lomonosov's progressive philosophy and prevent it from spreading among the masses.

Mention should also be made of analogous fabrications concocted by A. Preobrazhensky, who asserts that Lomonosov repeated the Leibniz-Wolff thesis on the active spiritual origin of life. In an article entitled "The Moral Make-up of M. V. Lomonosov and Some Basic Features of His Philosophy", Preobrazhensky proclaims Lomonosov a true follower of Wolff's idealistic philosophy, and offers the conclusion that "Lomonosov, like his philosophical helmsman, refuses to regard life as a wickerwork of blind and chance events, but as a general harmony, the harmonious scale of the world's concord, co-ordinated cosmos, and while he regards God as the architect and creator of all life, he does not consider the will of God to be the immediate cause of all phenomena taking place in the spiritual and physical world."** According to Preobrazhensky, Lomonosov never took a step without Wolff's guidance and never deviated from the road indicated by his mentor.

"Lomonosov", this theologian concludes, "was closely associated with his philosophical mentor. Wolff was the first to open before him the broad horizons of free rational thought, and by his own lofty example was the first to inspire him courageously to oppose obsolete ideas and routine."*** In Preobrazhensky's interpretation obsolete ideas did not mean reactionary philosophy, but materialism and atheism.

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* P. Sakulin, *Individuality of Lomonosov* (Russ. ed.), Moscow, 1912, pp. 136-37.

** *Lomonosov's Day in the Imperial Nikolayevsky University* (Russ. ed.), Saratov, 1911, p. 24.

*** Ibid., p. 25.

Finally, we must not forget I. Zamotin, who derived from his "original conception of the two elements, two beginnings in Russian society" the proposition that Lomonosov directly imitated the idealistic philosophy of Leibniz and Wolff. According to this conception Russian society had a passive beginning—inherent originality, inertness, mental indolence, etc., and an active beginning—the influence of Western civilisation. Zamotin makes out that Russian society owes its achievements only to the influence of the active beginning. In similar fashion he explains the appearance of Lomonosov.

Zamotin writes that Lomonosov diligently "studied philosophy, physics and logic under Wolff, and above all, assimilated the latest words and newest forms of European learning, which were vigorously advancing European culture".* Enlarging on the idea that Lomonosov became a great scientist and man of culture only as a result of the influence of Western civilisation, he draws the following generalised conclusion: "A synthesis of two elements—West European training and inherent originality—even then characterised Lomonosov's scientific and social activity.

"We have before us the beginnings of the type of public man in the new Russia who after Lomonosov worked most fruitfully throughout the 19th century."**

Such are the typical features of this basically erroneous trend in the interpretation of Lomonosov's philosophy and his vast scientific heritage, a trend which brought enormous harm to progressive Russian science and culture.

No less dangerous and harmful was the second trend whose adherents were the reactionary Slavophiles. They endeavoured to "prove" that his world outlook reflected the philosophy and theology of the Russian Orthodox Church. One of them was D. Galanin, the author of *Lomonosov, the World-Renowned Genius of Russian Culture*, which was published in Moscow in 1916. Though the work does contain a modicum of sense, it frankly advocates the reactionary Slavophile point of view. Galanin opens the book with premises that at first glance seem to be diametrically opposed to Tukalevsky's theories identifying Lomonosov's basically materialist world outlook with Leibniz's idealist philosophy. Galanin rejects the idea that Lomonosov was influenced by either Leibniz or Wolff. He writes: "Lomonosov should by no means be considered a student of German philosophy or a disciple of German scientists. As an educated man, he naturally knew German literature and was abreast of German research in various branches of knowledge, and drew upon them when he needed them; but the source of his world outlook and his freely-flowing brilliant constructions was Russian philosophical thought."*

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* I. Zamotin, *Two Elements in Lomonosov's Literary and Public Activity* (Russ. ed.), Warsaw, 1911, p. 3.

** Ibid., pp. 3-4.

What does Galanin mean by Russian philosophical thought? What he has in mind is the Russian brand of idealistic philosophy which was but a handmaiden to the Christian religion. "Proceeding from the principles of Russian philosophy," he writes, "many people believe that knowledge and science are superfluous in life, that the 16th-17th-century Russian preachers of religious dogmas and moral principles had no use for science and considered that a person of little education was closer to God, that he was morally purer, simpler and more truthful."**

Russian philosophy, according to Galanin, is called upon, first and foremost, to uphold the Orthodox Church. As regards the sciences, they must be a means of serving God. It appears that the main thing is to "know the human soul and to understand what religion requires, that is, to understand the supreme truth, the meaning of pure love and the true beauty of life", and only after this comes the need "to understand the physical world and its involved social relations".***

Basically this is also the same view of some modern scholars such as Lossky, Zenkovsky, Lellot and others. True they do not confine themselves exclusively to this trend, but seek to fuse the first and second into a single religious and idealistic conception.

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* D. Galanin, *Lomonosov, the World-Renowned Genius of Russian Culture* (Russ. ed.), Moscow, 1916, p. 79.

** Ibid., p. 79.

*** Ibid., p. 81.

The leading tendency in Lomonosov's generalisations is certainly not to rehash the thoughts of others, let alone imitate Western and Russian idealists as some investigators endeavour to "prove"; what he tries to do is to develop creatively the premises and principles of materialist philosophy on the basis of new scientific data and conclusions.

A careful examination of Lomonosov's works leads us to believe that he consistently preferred the writings of materialist philosophers and prominent natural scientists who had risen to the level of conscious philosophical generalisations.

The death-blow to most of the fabrications about Lomonosov is given by the list of philosophical books which Lomonosov actually used. G. Korovin's *The Library of Lomonosov,* a work of considerable scientific value, contains a list of philosophical books which he had in his library. Alongside the works of the Russian philosophers of his time N. Popovsky and G. Teplov, Korovin mentions Friedrich-Johann Buck's *Versuch einer philosophischen Abhandlung von den Stammeltern des menschlichen Geschlechts...*, Julien Offray de La Mettrie's *Les animaux plus que machines*, Nicolas de Malebranche's *Recherche de la Vérité,* and works by other West-European thinkers. Moreover, he lists the works of a large number of materialist philosophers who were also prominent natural scientists.

We know that Lomonosov had read the poem *On the Nature of Things* by the great Roman philosopher Titus Lucretius Carus, for he quotes from it in his work dealing with metal prospecting.

He writes: *"Lucretius's Opinion.* The ancient Roman poet and philosopher Lucretius attributes the invention of metals to the chance events which he sets down in the following verse:

"This clear discussed, learn next that
silver, gold, lead, hardier copper, iron, first were traced
When o'er the hills, some conflagration dire
Burned from its basis the deep-rooted grove;
By lightnings haply kindled, or the craft

Of hosts contending o'er the woodland scenes,
A double fear thus striking through their foes:
Or by the shepherd's wish his bounds t'enlarge
O'er tracts of specious promise; or, perchance,
Wild beasts to slaughter, and their spoils possess;
For such, with fire, and guileful pit, mankind
First caught, ere hounds were marshalled to the chace,
Or round the copse the mazy net-work drawn—

Whate'er the cause, when now the unctuous flame
Had from their utmost roots, with hideous crash,
Felled the tall trees, and, with its torrid heat,
The soil deep-reddened, rills of liquid gold,
Lead, silver, copper, through its fervid pores
Glided amain, and every hollow filled."*

Lomonosov also studied many works by Christian Wolff. In this connection it is appropriate briefly to describe his attitude to the German scientist. In Marburg Lomonosov attended many lectures delivered by Wolff and actually learned a great deal from them; but the knowledge he acquired was not of the kind the above authors claim. Science is indebted to Christian Wolff not because he was a follower and systematiser of Leibniz's idealist philosophy, but because, being a highly erudite scientist for those days, he did a great deal of important and useful work in spreading the achievements of natural sciences. Lomonosov and the other young men at Marburg University, who later became specialists in natural sciences and engineering, received great assistance from Wolff, who lectured on general mathematics, algebra, astronomy, physics, ethics, mechanics, geography, military and civil engineering, metaphysics, moral philosophy, politics, natural and civil law, and chronology. Wolff also conducted personal investigations into various branches of natural science, and compiled and published several natural science textbooks. One of them, *Experimental Physics*, proved to be of such interest that Lomonosov translated it into Russian in a slightly abridged form and published it under the title *Wolff's Experimental Physics, an Abridged Translation from the German Original Written in Latin.*

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* M. V. Lomonosov, *Complete Works*, Vol. 5, p. 441.

Christian Wolff's popularity as one of the leaders of enlightenment at the end of the 17th and in the first half of the 18th century was well merited. It is only natural that he should have evoked the hostility of reactionary German scientists. The attacks of German reactionary ideologists continued into the 19th century and reached such a pitch that Ludwig Feuerbach, the great German materialist, who was certainly not a follower of Leibniz's and Wolff's idealist philosophy, came out in defence of Wolff as a natural scientist and enlightener.

Replying to the reactionaries, Feuerbach wrote: "You. who are so contemptuous of Wolff's name, can you boast of possessing his fundamental, all-embracing knowledge, his pure, infinite love for science and truth, and the self-denial with which he lowered himself to the wretched level of his contemporaries so as to bring a ray of light into heavy German heads? It would be a boon to the German people if a new Wolff appeared in their midst."*

As regards Lomonosov's attitude to Wolff's idealist philosophy, modern research has fully established that he was not its adherent.

Returning to the theoretical sources of Lomonosov's world outlook, it should be re-emphasised that his philosophy was principally based on preceding materialist teachings and the scientific theories that were closely related to them. His most serious studies were of those materialists who were developing and concretising philosophical principles on the basis of new investigations and generalisations in natural science.

A philosopher is either a materialist or an idealist depending on how he answers the fundamental question of philosophy: which comes first, nature or spirit? Lomonosov considered that nature, or matter, in all its manifestations exists outside of and independently of human consciousness. He explained natural processes and phenomena on the basis of material causes and laws, and rejected all attempts to explain natural phenomena with the help of non-material factors such as heat- and sound-producing fluids and so forth; he wanted scientists to see nature as it really was, to draw their knowledge only from nature, and not to impose on it what it did not possess.

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* *M. V. Lomonosov.* A Collection of Historic and Literary Articles (Russ. ed.), Moscow, 1912, p. 50.

"I have already proved," he wrote, "that Aristotle's elementary fire, or, according to the new scientific terminology, a special heat-producing matter which, roving at random, passes from body to body without any plausible reason, is nothing but a fabrication; it has been proved that both fire and heat are produced by the rotational motion of particles and particularly of the matter forming the bodies in which these phenomena take place. This thesis of mine is well-guarded against unfounded objections, and such vain arguments have been proved groundless. Furthermore, it has acquired new irrefutable facts in its favour."*

Lomonosov's contribution to the fundamental problem of philosophy lies not so much in the materialist principle he chose in investigating natural phenomena, but in the new, scientifically-grounded arguments he advanced in support of this basic premise of his philosophy. His law of the conservation of matter and motion was a new and extremely important proof that materialism was correct in proclaiming that nature exists objectively, that it cannot appear from nothing, nor turn into nothing.

Great thinkers even before his time had also considered matter eternal. Lomonosov knew that the materialists of ancient Greece and Rome in general recognised that matter was eternal. Democritus, for instance, believed that only atoms and vacuum exist, that nothing is created out of that which does not exist, and that nothing turns into that which does not exist.

Epicurus, who also reasoned in a similar fashion, wrote: "Nothing is created out of that which does not exist: for if it were, everything would be created out of everything with no need of seeds. And again, if that which disappears were destroyed into that which did not exist, all things would have perished, since that into which they were dissolved would not exist. Furthermore, the universe always was such as it is now, and always will be the same. For there is nothing into which it changes: for outside the universe there is nothing which could come into it and bring about the change."*

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* M. V. Lomonosov, *Complete Works*, Vol. 3, p. 389.

The materialist Lucretius Carus in his brilliant poem *On the Nature of Things*, reproduces and concretises his predecessors' premises about eternal and imperishable matter. He conveys his thoughts in the following words:

"What then is solid, and from vacuum free,
Must undecayed, and still eternal live.
Were matter not eternal, ages since
All had returned to nothing whence it sprang,
And from that nothing all again revived.
But since from nothing nought can ever rise,
As proved above, nor aught to nothing shrink,
Seeds there must be of ever-during date,
To which, perpetual, things dissolve, or whence
Flows the fresh pabulum that all repairs.
But seeds thus simple must be solid too;
Else unpreserved through countless ages past,
*And useless to recruit th' exhausted world."***

A whole group of progressive thinkers, who, in one or another form defended the idea that matter was eternal, came to the fore in the period of the break-up of the feudal system and the rise of capitalism. Giordano Bruno, the great Italian philosopher, developing the premises of the ancient materialists, maintained that the universe is eternal and infinite; that it embraces all existence. Outside eternal and infinite existence there is nothing and nothing can be there. Existence is composed of innumerable things and objects.

Galileo Galilei, the Italian scientist and philosopher, played a significant role in substantiating the idea that matter is eternal. He recognised that eternal and invariable matter by its very nature possesses such properties as magnitude and shape, and that it can be either in a state of rest or in motion.

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* *The Stoic and Epicurean Philosophers. The Complete Extant Writings of Epicurus, Epictetus, Lucretius, Marcus Aurelius*, New York, 1940, p. 4.

** Lucretius, *On the Nature of Things*, London, 1898, pp. 317-18.

The eminent French materialist Pierre Gassendi also defended this materialist conception and asserted that there exists matter from which things are produced and to which they return after perishing and that, therefore, nothing is produced out of nothing, and that what exists does not turn into nothing.

Already at that time prominent thinkers, while examining the problem of the eternity of matter, were endeavouring to ascertain the relationship between human consciousness and eternal matter. Descartes considered that besides material substance, or eternal matter, there also exists eternal spiritual substance. Material substance, first and foremost possesses extension, width and depth, and is simple, or elementary. Dwelling on this type of substance, Descartes formulated his brilliant concept of the conservation of matter. "...It seems to me absolutely ridiculous," he stated, "that something should increase in size or extension without some new substance which also occupies space, or a new body, joining it; for it is impossible to conceive any increase in size or extension of something without it being joined by a substance having size and extension."* He writes further: "...It cannot be that even the smallest quantity or extension should be destroyed without there being a similar decrease in substance, and contrariwise, any decrease in substance inevitably entails a similar decrease in quantity and extension."** Descartes reaches the following generalised conclusion about material substance: "Hence, there only exists one kind of matter in the universe; and we know about it only because of its extension. All the properties which we can distinctly perceive may be reduced to the fact that it is divisible and movable in its parts and, therefore, falls into various arrangements as a result of the motion of its parts."***

On the other hand, Descartes, being a metaphysician, was unable to explain the essence of consciousness as a property which is not inherent in all material substances, but only in highly developed and highly organised living beings. The level of knowledge at the time was not high enough to provide the answer to this problem and Descartes draws the erroneous conclusion that alongside the material substance there also exists an eternal spiritual substance.

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* *Oeuvres philosophiques de Descartes*, t. I, Paris, 1835, pp. 278-79.

** Ibid., p. 279.

*** Ibid., p. 289.

Some years later Benedict Spinoza, the brilliant Dutch philosopher, tried to overcome Descartes' dualism by elaborating a theory that there is but one universal substance. "By substance," he wrote, "I mean that which is in itself, and is conceived through itself: in other words, that of which a conception can be formed independently of any other conception."[*] Further Spinoza reaches the conclusion that there can exist only one substance. He wrote: "There cannot exist in the universe two or more substances having the same nature or attribute."[**] Substance, he claims, is infinite and eternal.

An important part in providing a scientific substantiation of the concept of eternal matter was played by Isaac Newton, the great English scientist.

Lomonosov was well acquainted with all, or at least, the majority of these concepts, as can be seen from his numerous references to the works of Lucretius, Descartes, Newton and other thinkers who advanced concepts about the eternity of matter and the invariability of substance. Nevertheless, we have no grounds for asserting that the law of the conservation of matter and motion as a general law of nature was discovered before Lomonosov. The fact is that the great materialists of previous centuries did not formulate these conceptions as a general law of nature, nor did they provide convincing experimental proof of this universal law. Mendeleyev rightly asserts that the discovery of a law of nature belongs to the person who first clearly conceives it, and not to those who vaguely conjecture it, that it belongs to him who on the basis of facts and deductions convinces himself and others of its existence. It is in this sense that Lomonosov was the first to discover the law of the conservation of matter and motion, to substantiate it by experimentation and make it the property of science.

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[*] *The Chief Works of Benedict Spinoza*, Vol. II, New York, 1951, p. 45.

[**] Ibid., p. 47.

This law became the cornerstone of the materialist conception of nature, and a new principle of materialist philosophy.

Lomonosov built up his conception of the conservation of matter and motion during his first experiments, but propounded it only in 1748. In a letter to Leonhard Euler on July 5 that year, he wrote: "...all the changes occurring in nature follow the law that what is lost by one body is gained by another. For example, the loss of matter in one body is fully compensated in another. The hours I spend in sleep will reduce by the same number the hours when I am awake. This universal law of nature also extends to the law of motion, since a body that moves another body by its force will itself lose as much of its motion as it communicates to the one it moves."*

He was the first to advance and defend the idea that all types of nature or material substance are subject to this law.

Academician S. Vavilov justifiably pointed out: "In contrast to his predecessors, Lomonosov spoke of the 'changes occurring in nature', and mentioned separate instances of the conservation of matter, the conservation of time and the conservation of force only as examples. One can imagine that when Lomonosov penned the above lines he had in his mind's eye an incomparably more profound understanding of matter than the limited, specialised image characterised by mass and 'impermeability' which 18th-century physicists envisaged when speaking of matter. Lomonosov also speaks of this matter, but only as a particular instance of material substance. The other matter, in the general sense, which embraces 'all the changes occurring in nature' and is conserved as a whole, which Lomonosov had in mind, is close to Lenin's dialectico-materialist, philosophical understanding of matter."**

In subsequent years, Lomonosov with the help of various experiments, such as annealing metals in sealed glass vessels, irrefutably proved the correctness of his law of the conservation of matter and motion and on the strength of it made brilliant scientific and philosophical deductions.

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* M. V. Lomonosov, *Complete Works*, Vol. 2, pp. 183-85.

** S. Vavilov, *Collected Works* (Russ. ed.), Vol. III, U.S.S.R. Academy of Sciences Publishing House, Moscow, 1956, p. 98.

In 1756, summing up the results of laboratory experiments, Lomonosov wrote: "In chemistry: (1) apart from various chemical experiments, described in a diary of 13 pages, other experiments were conducted during which metals were annealed in sealed glass vessels in order to ascertain whether metal increases in weight as a result of heat; these experiments showed that good Robert Boyle had erred, for without outside air the weight of annealed metal remained unchanged."*

Lomonosov was a great scientist and materialist philosopher not only because he advanced indubitable scientific proof of his law, but also because he understood it as a general law of the universe. Furthermore, having scientifically substantiated that not only matter but also motion cannot be either destroyed or created, he introduced new incontrovertible scientific evidence, verifying the correctness of the materialist theory that matter is primary, and that matter and motion are one.

The assertion that it was not Lomonosov who first discovered the law of the conservation of matter and motion, but Antoine Lavoisier, is not true. While legitimately defending Lomonosov's priority in discovering this law, we have no intention of belittling the great Frenchman's contribution to science. Lomonosov discovered this law independently and long before Lavoisier did. Investigations conducted by Soviet scientists (Y. Dorfman's *Lavoisier*, etc.) offer sufficient evidence that Lavoisier had studied some of Lomonosov's works on natural science in which the latter not only applied this law but also defined it. In the 70s of the 18th century, Lavoisier applied the law of the conservation of matter as an empirical rule to calculate the number of substances which are used in laboratory experiments in chemistry. Lavoisier was one of the greatest scientists of France of the 18th century who played an outstanding role in developing natural science, including the application of the law of the conservation of matter in various chemical reactions.

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* M. V. Lomonosov, *Complete Works*, Vol. 10, p. 392.

In his *Scientific Course in Chemistry*, published in 1789, Lavoisier wrote: "... in all the operations of art and nature, nothing is created; an equal quantity of matter exists both before and after the experiment.... Upon this principle, the whole art of performing chemical experiments depends...."[*]

Unlike Lomonosov, Lavoisier was a natural scientist of the empirical trend who did not rise to the level of advancing general theoretical, let alone philosophical conclusions. This is reflected in the fact that he somewhat underestimated the role of scientific hypotheses. "...I have made it a rule for myself," he used to say, "...never to form any conclusion which is not an immediate consequence necessarily derived from observation and experiment...."[**] Elsewhere he makes this point still clearer: "I might have hazarded some conjectures, but I consider that they would be out of place in a chemical work, where every step has to be based on experiment."[***] His premise that every conclusion should be substantiated by experimentation is correct and has definite scientific value. But in some measure he used experiment to counter scientific hypothesis.

On the basis of his law of the conservation of matter and motion and other scientific principles Lomonosov further elaborated the most important problem of philosophy, the problem of matter and its properties. We know that he was familiar with the conceptions of material substance expounded by Aristotle, Lucretius, Galileo, Gassendi, Huygens, Newton and other philosophers and scientists, and in tackling the problem of matter drew on everything he considered correct in their works. For example, he pointed out that "Aristotle's primary matter called ὕλη is identical with elementary essence, in other words, with something whose content and quantity it is impossible to ascertain".[****]

In determining the nature of matter Lomonosov formulated broad generalisations resting on achievements in various branches of knowledge. Without going beyond the limits of the science of his day he made a brilliant effort to sum up the most common properties of all bodies and natural phenomena in one brief definition. "Beginning our discourse on matter," he wrote, "we should formulate its definition: matter is something that has extension, that is impenetrable and can be divided into insensitive parts (but first we must say that bodies are composed of matter and have shape, and show that the latter depends on the former)."*

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[*] *Oeuvres de Lavoisier*, t. I, Paris, 1864, p. 101.

[**] Ibid., p. 4.

[***] Ibid., t. III, p. 124.

[****] M. V. Lomonosov, *Complete Works*, Vol. 1, p. 119.

Further on he gives a still more general definition: "... matter is that out of which a body is comprised and on which its essence depends."** Lomonosov rejected idealist notions about non-material forces and the spiritual first-beginning, and insisted that everything taking place in bodies is determined by their essence and nature.

Unlike Democritus, Lucretius and other ancient atomists and some materialists of the 16th-18th centuries, including Gassendi and Newton, who asserted that the material objective world was composed of atoms and vacuum, Lomonosov made an important step forward in this direction by holding that the entire objective world was matter manifested in two of its basic forms, namely, substance, which consisted of solid, fluid and gaseous bodies, and aether.

The most common properties inherent in a substance were extension, inertia, shape and motion. He repeatedly stressed that it was matter that gave bodies extension, force of resistance and motion. Lomonosov also devoted a great deal of attention to the problem of aether. "The matter," he wrote, "which communicates to us the sensations of light and heat is called aether both by ancient and by contemporary philosophers."*** This special sort of matter resembles a fluid having an inordinate capacity for flowing and motion.

Sometimes Lomonosov refers to these two types of matter as "true matter" and "extraneous matter". "True matter," he wrote, "is that out of which a body is formed, while extraneous matter is that which fills the spaces in a body which are not occupied by its own matter. Connected extraneous matter is that which moves together with a body and together with it acts on other bodies; extraneous flowing matter is that which does not move together with a body, but freely passes through its pores."* These two kinds of matter completely fill all space, and, therefore, according to Lomonosov, absolute vacuum does not exist. Thus, all natural phenomena occur either in a substance, or in aether, or with the simultaneous participation of both kinds of matter. He also ascertained the nature of some of the material processes taking place in aether. Light, electric and partly heat phenomena, he asserted, take place in aether because it is a very fine, extremely fluid and mobile material medium.

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* Ibid., p. 102.

** Ibid., p. 173.

*** Ibid., Vol. 3, p. 285.

His idea that aether was a specific kind of matter was extremely important at that time not only for furthering the development of natural science, but also for sustaining the fundamental premises of the materialist philosophy. Scientists were already well aware that in addition to solid, fluid and gaseous bodies consisting of elementary and compound particles (atoms, molecules) there exists another material medium where light, electric and heat processes take place. Lomonosov and other prominent scientists called this medium aether. But he went further and sought to concretise all the available knowledge about this material medium by elaborating new theories about heat, light and electricity—processes which expressed some of the characteristic features of this medium.

The idea that aether was a special kind of material substance continued to dominate both natural science and materialist philosophy long after Lomonosov's death. Even Mendeleyev persistently endeavoured to fathom its chemical and physical properties. In a special paper *An Attempt at a Chemical Understanding of Universal Aether* D. Mendeleyev wrote: "Already in the 70s I was plagued with the problem: what is aether in the chemical sense? At first I thought that it was the sum total of rarefied gases in their ultimate state. I employed low pressure in my experiments in an effort to obtain a clue to the answer."* He assumed that aether was a specific mixture of certain gases whose state was close to the ultimate.

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* M. V. Lomonosov, *Complete Works*, Vol. 1, p. 191.

It was only in the 20th century that developing scientific thought convincingly proved that the old conception of aether was completely at variance with natural science, and the idea of aether was rejected by scientists. But the idea that apart from material substance there exist other forms of matter is not only not disproved by modern science, but, on the contrary, is brilliantly sustained by it. The heat, light and electric processes in nature, which Lomonosov had studied with such persistence, modern science also regards as manifestations of a specific material medium in the form of an electro-magnetic field.

Due to the fact that in his day knowledge was limited and one-sided, Lomonosov simplified nature by operating primarily with its mechanical properties and general laws. He defined matter from the physical and mathematical standpoint.

In line with the fundamental principles of atomistic materialism, Lomonosov held that matter consisted of infinitely small, indivisible and impenetrable physical particles or atoms.

"Many people," he wrote, "have a fixed belief that the method of philosophising based on the existence of atoms allegedly cannot explain the nature of bodies and their origin." But recognising that this conception was cardinally incorrect, he argued that "there are no other natural first-beginnings which could more lucidly and fully explain the nature of matter and universal motion".**

Developing the atomistic theory, Lomonosov also applied its principles to aether. This was yet another magnificent conjecture which was later sustained by modern science, although in somewhat different form. He wrote that particles forming aether were always in contact with one another. His conception of aether particles and their interconnection was, however, rather naive. He considered that aether particles were round and had a rough surface because this was the only way he could explain the origin of heat and light phenomena.

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* D. Mendeleyev, *Collected Works* (Russ. ed), Vol. II, Leningrad, 1934, p. 467.

** M. V. Lomonosov, *Complete Works*, Vol. I, p. 119.

"Aether particles are globular," he wrote.

"Proof:

"Aether particles disseminate heat by rotational motion ... this can take place only if they are round or almost round in shape. Therefore aether particles must be either round or close to being round."[*] But they could communicate heat to each other not by merely contacting each other but only if, in doing so, they caused friction This they could do, according to Lomonosov, if the surface of these globular particles was uneven. His argument ran as follows: "The round surface of aether particles is rough.

"Proof:

"Heat spreads through aether as a result of the rotational motion of its particles which are always in contact with the neighbouring ones. Let us suppose that their surface is absolutely even and smooth; in that case the surface of each particle will move over the surface of another without causing any friction."[**] Consequently, a moving aether particle would not be able to turn on its axis and impart motion to the neighbouring particle which was in contact with it and heat would not be produced.

Consistently adhering to the principles of materialist atomism in explaining the origin of bodies and natural phenomena, Lomonosov considered that living organisms also consisted of elementary inorganic bodies which in turn were formed of infinitely small particles. "... Although animal and vegetable organs are very cunningly constructed, they, nevertheless, consist of still smaller, inorganic particles, namely compound substances. For chemical action destroys their organic structure and they become compound substances. Thus, all compounds obtained from animal or vegetable matter either by nature herself, or artificially, are also chemical matter. Hence, we can clearly see that the laws of chemistry are effective in all bodies. . . ."[***] For his day this approach to the study of living organisms was basically scientific and effective, and served to sustain the correctness of materialist principles.

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[*] M. V. Lomonosov, *Complete Works*, Vol. 3, pp. 307-09.

[**] Ibid.

[***] Ibid., Vol. 2, p. 555.

Lomonosov, as we have said earlier, enunciated the fundamental principles of atomic theory which became firmly established in chemistry and other natural sciences and formed one of the bulwarks of materialist philosophy. His materialist explanation of atoms and molecules was quite thorough for the time. He believed that because atoms differed in size, had different properties and did not always combine in the same numbers and arrangements, the molecules, or corpuscles which were formed out of them also came in a multitude of types. He divides them into two large groups—homogeneous and heterogeneous. Corpuscles are homogeneous if they consist of an equal number of identical atoms linked together in an identical manner.

Proof of the existence of such corpuscles is afforded by homogeneous masses, all parts of which are like the whole. Indeed, if they did not exist there would be no homogeneous mass, for its corpuscles would be different in any given part and our senses would respond to each corpuscle in a different way; consequently no corpuscle would be the same as another. In other words there would be no homogeneous masses, which contradicts the results of experiments.

"Corpuscles are heterogeneous," Lomonosov continued, "when their elements are different and are linked in different numbers, or arrangements. This fact determines the infinite variety of bodies."*

He also discovered some general laws of the interaction between atoms and molecules. He considered that a compound substance consisted of two or more different atoms linked together into a molecule; in a compound substance the ratio between its elements was the same as the ratio between the elements of each of its molecules. The fundamental principles of the atomic theory developed by Lomonosov were borne out by subsequent scientific discoveries.

Lomonosov concretised and further developed the principle of integrity of the material world on the basis of the law of the conservation of matter and motion, the atomistic theory and recognition of the existence of two types of matter. He had no illusions about the difficulties with which he had to contend. "It is extremely difficult to lay foundations," he wrote. "For (in doing so) we must at a single glance perceive the aggregate of all things so as not to arrive at contradictory conclusions.... Nevertheless, I make bold to do so here, relying on the premise or the maxim that nature rigidly conforms to its laws and is the same everywhere."*

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* Ibid., pp. 79-81.

He based his idea of the integrity of all material objects on the causal relationship between them, which he viewed as one of the common and the most durable laws of nature. It is characteristic of nature, he said, that it gives rise to an infinite number of phenomena and properties out of a small number of causes.

At the same time he opposed all attempts to attribute one or another effect to some invented cause. He held that in explaining natural phenomena only the basic causes should be considered, while it was necessary to seek for common causes when examining homogeneous phenomena.

"We must not recognise other causes of natural phenomena other than those which correspond to reality and are sufficient to explain these phenomena," he wrote. "Therefore homogeneous phenomena have common causes. as for example, those which make a man or an animal breathe, that make a rock fall in Europe, or America, a kitchen fire or the sun to radiate light, the Earth and the planets to reflect light...."**

Lomonosov applied these general premises to reveal the peculiarities of the causal relationship in various natural bodies. In organic nature, he asserts, "particles of bodies are arranged and cohere in such a manner that the cause of the effect in one particle lies in its neighbouring, cohering particle. In inorganic bodies particles have no causal relationship apart from their mutual cohesion and arrangement".***

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* M. V. Lomonosov, *Complete Works*, Vol. 1, p. 135.

** Ibid., Vol. 2, p. 71.

*** Ibid., Vol. 3, p. 347.

He advanced the following argument to sustain his view on the unity of the material world:

"The nature of things is the same everywhere. For example, water, gold and air are the same in Europe and in America. Consequently, gold will also be the same on Saturn."* He also believed that the Earth, the planets and the comets have the same air.

Developing this thought, he reaches the conclusion that the nature and the laws of light phenomena are identical in all parts of the universe. "The light rays emitted by stationary stars," he writes, "are refracted in the air because different colours are visible. They are also refracted in water and other transparent bodies. Furthermore, they are red when reflected from a red surface, etc., and are governed by the same objective laws as the rays of the Sun and other luminous bodies. Hence, the nature and the motion of their luminous matter is the same on the Sun and on the Earth. The bodies which emit this light are related to the Sun, just as bodies on the Earth are related to the Sun's rays. And when two things are related to a third, they are also related to each other."**

Lomonosov regards all animal and plant life, including man, from the standpoint of unity of the material world.

He divides all bodies and objects of the first type of matter—substance—into three big groups—inorganic bodies, plants, and animals. These groups have much in common, they are subject to the same causes and general laws of development, but at the same time they differ from each other because of their properties and qualities. Moreover, they are united not by divine force, but by nature itself, and, therefore, form a single whole. "All bodies created by nature," he writes, "are divided into three kinds. The first kind consists of all animals, that is, people, cattle, beasts, fishes and reptiles; the second—trees, grasses and all other plants; the third is composed of minerals, that is rock matter, namely: metals, non-malleable metals, thick mineral juices, mineral waters, soils and stones."***

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* Ibid.

** Ibid.

*** Ibid., Vol. 5, p. 367.

His materialist generalisations about three categories of bodies organically connected with each other and possessing common properties and objective laws prove that he explained natural phenomena on the basis of nature itself without attributing them to a divine first-beginning. He considered that nature itself gave birth not only to minerals, plants and animals, but also to humankind.

Lomonosov's works contain valuable and in many ways original thoughts and premises concerning such properties of matter as extension and space. His studies of this problem were based on previous achievements in natural science and materialist philosophy. Applying the laws of mechanics of celestial and earthly bodies, chemical and physical laws, materialist philosophy and other branches of knowledge, he came to the conclusion that extension and space were the inherent and inalienable properties of all bodies. By space he meant the length, depth and width of a body. All bodies, whether giant stars, or the tiniest particles of matter or aether occupied space in three dimensions.

In those days materialist philosophers and scientists entertained two conceptions about space. One group maintained that alongside material bodies there independently exists a void. At the close of the 17th and the beginning of the 18th century this conception was supported by Isaac Newton, who held that absolute space, irrespective of anything extraneous, was by its very nature always invariable and immobile.

The other group believed that space was nothing more than extension of bodies, and that, therefore, there was no such thing as an absolute void. The most profound philosophical substantiation of this premise was made by Descartes in his *Principles of Philosophy*. He wrote: "It is evident that a void in the philosophical sense of the word, that is, space which has no substance, does not exist, for space as an internal place is in no way different from the extension of a body. Merely from the fact that a body has length, width and depth we draw the correct conclusion that space is substance, for it is altogether impossible to imagine that 'nothing' can have extension. Concerning space that we considered empty, we should also have to conclude that if it has extension it must also have substance."[*]

Lomonosov fully adhered to this second concept. He worked hard on the problem of extension of infinitely small particles, considering that to understand and explain the essence of natural bodies it is necessary to recognise the existence of these particles which possess material properties, including extension. The failure to understand that extension is an essential property of bodies, he wrote, "has beguiled scientists into serious dispute about elementary substances, that is, about particles which have no extension. We know that a body is a body because it has extension. and that extension is one of its most important definitions. therefore, it is ridiculous to argue that a body is composed of particles having no extension, for in this case it is necessary to seek definitions of proofs instead of deducing proof from definitions, as is the proper and customary thing to do."[**] He criticised Leibniz and his followers who held that the infinitely small particles of a body had no extension, and, consequently, lacked material properties. and he pointed out that extension was an inalienable property of all bodies without which they could not exist. Accordingly, even the smallest physical particle had extension. Therefore, he wrote, assertions that a body was composed of particles that had no extension were scientifically unfounded. He legitimately stressed that if particles had no extension they could not form a body.

His concept of time, like that of space, was also indissolubly associated with nature and matter. He held that motion and changes in the structure and form of bodies occur in time, that is, in the period in which these changes alternately take place. He devoted much attention to the problem of time in *On the Layers of the Earth*, in which he discussed various natural, particularly geological, phenomena.

He explained the force of gravity which is inherent in all bodies also from a materialist point of view. "We cannot," he wrote, "attribute such a physical property of bodies as gravity to God's will or some sort of miraculous force, without blaspheming God and nature; we must agree that there exists a certain kind of matter whose motion impels gravitating bodies towards the centre of the Earth."*

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[*] *Oeuvres Philosophiques de Descartes*, t. I, pp. 284-85.

[**] M. V. Lomonosov, *Complete Works*, Vol. 3, p. 385.

Lomonosov's original scientific investigations and his materialist conclusions regarding the atomic structure of all bodies dealt a serious blow to Leibniz's idealistic monadology, which was fairly widespread among Russian scientists at the time.

In some of his works Lomonosov disproves the existence of so-called spiritual monads, arguing that everything in the universe is composed of material particles possessing extension and other material properties. He wrote a letter to Leonhard Euler saying that in attacking prominent scientists he did not want "to appear to be more of a boaster than a seeker after truth" and that this thought had for a long time prevented him from presenting his ideas about monads to the scientific world for discussion. "Although I am sure that my proofs will completely demolish this mystical teaching," he continued, "I do not want to darken the declining years of the eminent man (Christian Wolff—*G.V.*) whose generosity towards me I cannot forget, otherwise I should not have been afraid to disturb the hornets' nest of monadists in Germany."**

Under the influence of Lomonosov's ideas, many 18th-century West European scientists became critical of Leibniz's and Wolff's monadology.

The scientific substantiation of the atomic theory with which Lomonosov opposed Leibniz's monadology and other varieties of idealism may be used today, too, as an instrument against modern "physical" idealists such as Pascual Jordan, for example, who, in effect, is resurrecting Leibniz's reactionary theory of spiritual monads and is endeavouring to "prove" that the atom has no sensuous qualities and can be described only in mathematical terms.

Lomonosov's brilliant generalisations on the nature and forms of motion were a new step forward in the development of materialist philosophy. Motion, according to

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* M. V. Lomonosov, *Complete Works*, Vol. 2, p. 197.

** Ibid., Vol. 10, p. 503.

Lomonosov, is an inherent property of all bodies, whether giant stars or infinitely small physical particles—corpuscles and atoms. The interminable process of creation and destruction of bodies, in his opinion, irrefutably proves that motion is the basic property of matter. He sustains this idea by asserting that in both dead and living bodies atoms and corpuscles are in a state of constant motion.

Explaining the nature of motion, he rejects the idealist notion of an initial "divine push" and strives to prove that the motion of matter is constant. In his work *On the Weight of Bodies and Constancy of Primary Motion*, first published in Volume 2 of his *Complete Works*, Lomonosov emphasises that there is both primary and derived motion. Primary motion, in his opinion, is that which is not originated by other motion, but whose cause lies in itself, while derived motion is that which is originated by external motion. He considered that acceleration of falling bodies is derived motion and also that it has a beginning. Conversely, primary motion cannot have a beginning and exists constantly. He sustains this conclusion in the following way: "Let us suppose that primary motion does not exist constantly; it follows then that there was a time when it did not exist and that a moving body was at rest until motion was imparted to it. From this we may conclude that something extraneous set it in motion and, consequently, that primary motion was not primary. This, however, is a contradiction. Therefore it is necessary to accept the opposite and agree that primary motion never had and cannot have a beginning and must continue perpetually."*

Derived motion directly depends on some other motion. Hence, "the acceleration of a falling body is motion which it previously did not have and is, therefore, derived motion. But inasmuch as this motion is connected with gravitation and is an effect of the same cause which makes a body gravitate towards the centre of the Earth, it becomes obvious that gravitation is derived motion and consequently depends on another moving (body)".**

Motion, Lomonosov considered, was an inherent property of matter and a source of the transformations occurring in material objects. In other words, transformations are impossible without motion being involved.

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* Ibid., Vol. 2, pp. 201-03.

** Ibid., p. 197.

He legitimately asserted: "We should not deny the existence of motion where it is not visible: who, indeed, will deny that when a strong wind blows through the woods the leaves and the branches move, even though from a distance this movement cannot be perceived. As in the case of distance, the smallness of the particles, too, makes the motion of matter in hot bodies invisible; in both instances, the angle of vision is so acute as to make it impossible to see either the particles themselves, or their motion. But I think that no one, unless he is an adherent of latent properties, will attribute heat, the source of so many transformations, to tranquil matter devoid of motion and, consequently, of motive power".[*]

Lomonosov understood motion first and foremost as the movement of bodies in space. From these positions he defined different types of motion. Bodies, he said, can move in two ways—total motion, when the whole body changes its place, and internal motion, which is the movement of the infinitely small particles of the body.

"Each body, we may assume," he wrote, "can have three types of motion, which are characteristic of the motion of all other bodies: 1) translational, when the whole body constantly changes its place; 2) rotational, when a body while remaining in the same position moves around its permanent or changing axis; 3) oscillatory, when a body moves back and forth with great speed within an infinitely small space."[**]

Dealing specifically with the general proposition that motion is an inalienable property of matter, Lomonosov points out that aether too is in a state of constant motion, and that the motion of its particles is also of three types—translational, rotational and oscillatory. In his *Report on the Origin of Light Propounding a New Theory of Colours*, Lomonosov treats of the nature of light, its causes and the laws governing its motion. Explaining the motion of aether, he further develops the ideas of prominent scientists who had tackled this problem before he did. "In order to obtain a clear and detailed understanding," he writes, "it is necessary to examine all existing motions of matter in general. Thus, we now agreed that light is some sort of fine, fluid and impalpable matter and consider it possible to say that it possesses three types of motion. Whether this is true will be disclosed later. First, according to Gassendi and Newton, the motion of aether (the name given to the matter of light by old and many new scientists), which streams from the Sun and other big and small luminous bodies and spreads in all directions like the flood waters of a river, might be flowing or translational. Second, Cartesius and Huygens consider that this motion might be oscillatory, in other words, that light spreads from the Sun through matter-filled universal space in the form of very small numerous waves like the concentric waves which spread over the surface of a still patch of water after a stone has fallen into it. The third type of motion might be rotational, that is when each insensitive aether particle rotates around its centre or axis. I have begun a serious study of the problem, considering it quite probable that these three types of motion are inherent in aether and that they can actually produce light and colours."*

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[*] M. V. Lomonosov, *Complete Works*, Vol. 2, p. 11.

[**] Ibid., Vol. 3, p. 289.

He recognised the existence of all three types of motion in aether and considered them the source of heat, light and electric phenomena. At the same time he entirely rejected the idea of any spiritual first-beginning.

Basically an adherent of mechanistic materialism he, nevertheless, sought for an explanation of motion outside the narrow limits of this teaching. He concludes that it is the various types of motion which occasion such qualitatively different processes as heat and light, and on the basis of a series of examples and experiments proves that they are not only different natural phenomena, but are also relatively independent of each other. "It follows," he writes, "that since heat can exist without light and light without heat, they are the effect of different causes. Aether is the medium through which the Sun's heat and light reach things on

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* Ibid., p. 319.

Earth. Therefore both are transmitted by the same matter but by different types of motion."*

Lomonosov regarded motion as one of the fundamental properties of matter and at the same time emphasised that it was not its only property and therefore it was erroneous to identify matter and motion. "A person who cannot see the difference between aether and light," he wrote, "will be unable to distinguish between air and sound." Natural science had not advanced far enough in the 18th century for Lomonosov to be able to demonstrate concretely the specific qualities of electricity- and light-producing types of motion and the difference between them and mechanical motion.

He was far ahead of many materialist philosophers of his day because in his approach to the solution of new philosophical questions, including the problem of matter and motion, he had full command of all the knowledge accumulated by scientists over the centuries as well as his own scientific discoveries and theoretical generalisations.

The theory of primary and secondary properties advanced by Galileo, Locke and other scientists and philosophers was very popular in Lomonosov's time. Its adherents maintained that only the primary properties of bodies—extension, shape, weight and inertia—exist objectively and reflect their entire essence, whereas all the other properties, including heat, smell, colour and sound, do not exist objectively and are nothing more than the subjective creation of the human mind.

Galileo formulated this concept in the following way: "I shall never seek any other properties in extraneous objects other than magnitude, shape, number or more or less rapid motion in order to explain the sensation of taste, smell, or sound; I think that if we did away with ears, tongues and noses, only shapes, number and motion would be left, but not smells, tastes or sounds which, I hold, exist outside a living being as nothing more than names."**

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* M. V. Lomonosov, *Complete Works*, Vol. 3, pp. 326-27.

** Gulileo Galilei, "On Sensuous Beginnings", quoted from A. Deborin's *Book for Reading on the History of Philosophy* (Russ. ed.), Novaya Moskva Publishing House, 1924, pp. 175-76.

The conviction that only primary properties existed objectively led Galileo to appraise many other properties of objects from subjective positions, which had a negative effect on the development of scientific thinking. It was this subjective understanding of heat, light and electricity that made it impossible to study them thoroughly, since according to this concept they had no objective existence. Galileo's explanation of heat illustrates this point.

Applying his theory of primary and secondary properties. he concluded that heat, being a secondary property, in effect did not objectively exist. He wrote: "...many of those sensations which were considered to be the inherent properties of extraneous bodies, exist independently of us, but not in them; outside of us they are nothing more than empty words. I am inclined to think that heat is also the same sort of sensation, and the matter which arouses our sensation of heat and which we call by the general name of fire, is composed of a multitude of tiny bodies of a definite size ... they penetrate into it because of their extreme delicacy; the touches which are caused when these tiny bodies penetrate our material substance awaken in us a sensation of heat, which may be either pleasant or unpleasant depending on the number of these particles and the speed with which they move...."*

Developing his views on the nature of heat as a phenomenon which does not exist objectively, he further wrote: "I do not at all think that apart from shape, motion and the ability to penetrate and to touch, fire has any sort of inherent property called heat. On the contrary, I think that we, ourselves, are the source of this quality and that if we did away with animate and feeling substance, heat would be reduced to nothing more than an empty word."**

Naturally, such an understanding of heat did not stimulate scientists to study this natural phenomenon.

From the point of view of gnosiology the problem of primary and secondary properties was elaborated in detail by the 18th-century English philosopher John Locke. He based his sensualistic theory of cognition on recognition of two sources—external and internal—from which a human being derives his sensations and ideas. The external source is the influence of objectively existing material bodies on his organs of sense; the internal source is the activity of the soul and its influence on the senses. Locke does not deny that the sensation of softness, hardness, heat, colour and so forth, arises in a person as a result of the influence of external objects. But, following in the footsteps of Galileo, he was inclined to believe that sensations did not convey the actual properties of these bodies.

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* Ibid., p. 176.

** Ibid., pp. 176-77.

Thus, Locke thought that an object which had only primary properties stimulated subjective sensations by influencing man's organs of sense. It was natural, therefore, that the idealist George Berkeley used Locke's subjectivism to uphold the philosophy of subjective idealism and religion.

Recognition of the objective existence of only such properties as shape, extension, inertia and, partly, mechanical motion led to a definite overestimation of the role of mathematics and underestimation of the importance of other sciences. In those days mathematics was considered to be the only precise science, whereas other branches of knowledge whose subject matter was investigation of secondary properties were, according to Thomas Hobbes, descriptive sciences studying the "effects of sensations". Such an understanding of so-called secondary qualities in Lomonosov's time seriously impeded the development of natural sciences and philosophy.

Lomonosov was one of the first to oppose these theories and decisively sustained the materialist understanding of both primary and secondary properties. Many of his works contain scientific arguments upholding the idea that secondary properties also exist objectively and that they are inherent in all natural bodies.

"Material properties," he wrote, "are those which are attributed to animate and inanimate objects and are called extension, shape, weight, solidity, resiliency, motion, reverberation, colour, taste, smell, heat, cold and internal forces."*

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* M. V. Lomonosov, *Complete Works*, Vol. 7, p. 102.

He recognised the objective existence of colours and said that aether had red, yellow and blue particles. He summed up his ideas on the problem in the following words: "The aether of all three colours is unceasantly spreading in all directions; hence, its red, yellow and blue particles are also in constant motion. All this is possible only if aether corpuscles of varying mass penetrate into each others' pores."*

The difference between primary and secondary properties, according to Lomonosov, consisted first and foremost in the fact that the former are common to all bodies, whereas the latter are of a specific nature and characteristic of one or another body. He thought that there was an immense number of partial or secondary properties, as can be seen, for example, from the almost infinite variety of colours.

At the same time he maintained that secondary properties were bound up with primary properties and underlined the dependence of the former on the latter. The idea that a change in the fundamental properties of a body leads to a change in the secondary ones is correct in many ways. But owing to the level of science at the time he was unable to discover why properties in objects change and, consequently, to explain the mutual relations and interaction between the fundamental and secondary properties of material objects.

In recognising the objective existence of both primary and secondary properties, Lomonosov viewed the material world as one possessing great beauty and an infinite wealth of specific properties. This understanding of nature was very progressive for that time because it opened wide prospects for scientific development; and it was this recognition of the objective existence of such material objects as heat, light and electricity that permitted him to launch a thorough study of these properties.

Armed with a scientific, materialist understanding of natural properties, Lomonosov elaborated new, original theories which broadened the knowledge of nature in the 18th century.

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* Ibid., Vol. 3, p. 241.

Our presentation of Lomonosov's views on matter and its properties will be incomplete if we do not describe his conception of weight. Many great scientists and materialists of the 16th-18th centuries considered that weight, or ponderability, was an absolute, invariable property of all bodies. Lomonosov also believed that the weight of a body was a common property of matter and its finest particles. He maintained, however, that in this field, too, science had not said its final word. "Each time that we examine the great number of views on natural phenomena," he wrote, "it pains and amazes us that after such a tremendous amount of work by scientists, after so many wonderful discoveries, there is a great number of physical phenomena lacking adequate explanation, particularly in that branch of natural science which treats of a body's properties whose existence is determined by infinitely small and completely invisible particles. But our confusion shall decrease as soon as we recall that the fundamental principles of mechanics and, consequently, of physics are still not determined, and that the most brilliant scientists of the century have not yet arrived at an agreement with regard to them. The most vivid example of this is the measure of the force of motion which some consider as being in equal, and others in double, proportion to speed.

"Similarly, it is still undecided whether the proportion of the weight of bodies gives a correct measure of their mass."*

It was on the basis of the philosophic theory of common and specific properties of objects and natural phenomena that he sought to ascertain the nature of the weight of objects and to determine the character of the changes that occur in this property as a result of the changes in the amount of matter. He formulates this problem in the following general terms: "...most scientists apply the concept that the *amount of matter in bodies is proportional to their weight* as a canon, although there are many factors that speak against it and which are so essential as to merit the attention of the scientific world."** He considered that this concept could be applied only to homogeneous bodies, and that it was wrong to absolutise it and to apply it to heterogeneous bodies. After reading that Newton had applied this concept to air, Lomonosov legitimately asserted: "...we cannot unconditionally agree with his general conception that *mass is determined by the weight of each body*, for no conclusions may be drawn by proceeding from the particular to the general; and that what is fully applicable to homogeneous bodies does not necessarily apply to heterogeneous ones."*

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* M. V. Lomonosov, *Complete Works*, Vol. 3, p. 351.

** Ibid.

While working on this problem, Lomonosov also philosophically studied the question of whether or not gravitation, which determines the weight of bodies, is a universal property of matter. He opposed the idea that gravity was an essential attribute of bodies and held that a body might have no gravity and yet exist, saying that it resembled the amount of motion which is produced by the increase in the velocity of falling bodies.

He developed the idea that the weight of bodies is variable and brilliantly formulated one of the fundamental premises of materialism, which was adequately confirmed only 200 years later, namely: "...it should be borne in mind that when we say that the visible world is filled with matter, we should simultaneously concede that there is weightless matter in it, too, otherwise bodies could never rise in the aether fluid, nor fall due to the force of gravity. By recognising the existence of weightless matter, and proceeding from the big to the small, we conclude that there are various types of matter whose specific weight is smaller than that of other matter. This follows also by analogy from the other properties possessed by palpable bodies."**

On the basis of this general philosophical proposition Lomonosov deduces that ponderability is not a general attribute, but only a specific factor which a body may or may not have.

Lomonosov's works on the nature and properties of matter treat of many important problems. He was not only one of the first scientists to advance the proposition that motion is an attributive property of matter, but also convincingly proved it. He made a great contribution to science by putting a new construction on the interaction between the primary and secondary properties of matter. Furthermore, he made a detailed study of heat, light, electricity and many other secondary properties. He opposed the tendency to absolutise some specific properties (heat. ponderability) of bodies, and boldly advanced his own original view on them. When investigating natural phenomena, he not only applied the fundamental principles of materialist philosophy but also creatively developed these principles. It should be remembered, however, that in view of specific historical conditions his materialism was inconsistent. His philosophy contains elements of deism. But to understand the role and place of deism in Lomonosov's philosophy, we should be guided by Marx's proposition concerning the philosophy of the 16th-18th centuries to the effect that deism in those years was nothing more than an easy means for a materialist to keep away from religion. Deism occupied a definite, historically justified, place in the materialist philosophy of the 17th and 18th centuries. With some philosophers deism took the form of dualism, as was the case, for instance, with Descartes, who displayed it especially vividly in his explanation of the interaction between material and spiritual substance. "I," he wrote, "consider matter together with all its properties and attributes and think that God continues to preserve the original state of all the things he has created. And only because He continues to preserve matter in its invariable state, is it unavoidable that definite changes must take place in its parts. These changes, it seems to me, cannot be directly ascribed to God because He is unalterable; therefore, I attribute them to nature. And the rules which govern these changes I call the laws of nature."* Further Descartes reaches the conclusion that although God does interfere in nature, many material phenomena, such as motion and the variability of bodies, operate according to the laws of nature and, consequently, do not require divine intervention.

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* Ibid., p. 353.

** Ibid., p. 367.

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* *Oeuvres de Descartes*, t. XI, Paris, 1909, p. 37.

Materialists of the Spinoza school reveal their deism by identifying material substance with God, and proclaiming that all material substance possesses the property of thought.

Finally, there are materialists and natural scientists such as Newton, for example, who reveal their deism by claiming that there was a first-beginning, which they ascribe to providence.

In the philosophy of Lomonosov elements of deism, as a rule, were a means of avoiding idealism and religion in explaining natural phenomena. This may be seen from the fact *that in all his numerous works* on natural science he makes no reference to idealist principles, to religious dogmas, or to divine intervention. His statements such as God gave humanity two books one of which is science and the other—faith, that "truth and faith are in effect two sisters",* and that science and religion should pursue their own specific goals, are primarily aimed at emancipating science from the influence of scholastic philosophy and religion.

It should also be mentioned that Lomonosov often turned to religious forms of expression, especially in his literary works, in order to be able to voice his progressive scientific, philosophical, and social and political ideas.

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* M. V. Lomonosov, *Complete Works*, Vol. 4, p. 373.

Chapter V

THEORY OF COGNITION

In his theory of cognition Lomonosov also consciously upheld and creatively developed materialist principles. He considered that the material world was cognisable and opposed the idealists and agnostics who said that nature could not be known; he urged scientists to unravel the secrets of nature and not to be disheartened by the difficulties which might stand in their way. In a lecture on the origin of light he said: "It is difficult to investigate nature; nevertheless, it is pleasing, useful and sacred work. The more we fathom its secrets, the more our hearts will rejoice. The greater our zeal, the more fruit will be gathered for the needs of man."*

He believed that nature, in spite of the multiplicity of natural objects, phenomena and their inherent properties and attributes, had common foundations, features and laws and "rests firmly on its laws even in the smallest details which we ignore. For example—light. A detail should not be considered a miracle".**

He rendered a great service to science by recognising the existence of both primary and secondary properties, and remaining unshaken in his belief that it was possible to come to know them. "Studying natural objects," he wrote, "we find that they have two kinds of properties. The first are clearly and thoroughly understandable; the second cannot be described in detail although we can clearly imagine their existence. The first group includes extension, appearance, motion and the position of the whole object; the second—colour, taste, smell, medicinal properties and others. The properties of the first group can be thoroughly ascertained by means of geometry and mechanics. But this method is inapplicable to the second group for, unlike the first, which are inherent in all visible bodies, the second escape our senses because their origin lies in the infinitely small invisible particles. Yet to comprehend a thing down to its smallest detail we must have an exact knowledge of the nature of the particles forming it. . . ."* Further he said: ". . .that which is open to our sense of sight is followed by that which is sensed by our tongue, namely, various tastes. What we call taste are bodies causing either a pleasant or an unpleasant sensation to our tongue; tasteless bodies cause no sensation whatever. The principal and the most distinct tastes are: 1) sour, as in vinegar; 2) burning, as in spirits of wine; 3) sweet, as in honey; 4) bitter, as in tar; 5) salt, as in salt; 6) sharp, as in horse-radish; 7) astringent, as in unripe fruit. To explain which of these tastes are elementary and which are compound we shall first have to determine the nature of their beginnings."**

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* M. V. Lomonosov, *Complete Works*, Vol. 3, p. 317.

** Ibid., Vol. 1, p. 161.

But, since the infinitely small particles were cognisable, it followed that all properties occasioned by the nature and motion of these particles could also be fully explained.

In contrast to those who claimed that the unknown was unknowable, Lomonosov was absolutely sure that developing science and continued experimentation would bring to light more and more of nature's secrets. To sustain this premise he quoted facts from the development of various branches of natural science. We have only to compare what the ancient philosophers and natural scientists knew about nature with the level attained by science by the middle of the 18th century, he used to say, to realise how greatly people have enriched their knowledge of nature.

He himself enriched science with new data and propositions confirming the materialist principle that nature is cognisable.

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* Ibid., Vol. 2, p. 352.

** Ibid., p. 503.

Holding that man can learn to apprehend nature's properties and laws, he brilliantly sustains this idea by citing examples from various branches of natural science. Chemistry, in his opinion, can disclose the deepest secrets of compound substances and ascertain the nature of the infinitely small particles of bodies. "In vain," he writes, "does sly nature hide her treasures under such a simple screen and in such easily-discovered coffers, for the fine, probing fingers of chemistry can distinguish the useful from the useless, the precious from the base, and pierce her false shroud to discover the inner worth of things. In vain does she lock her riches in heavy rocks and surround them with substances that are detrimental to our lives, for with the help of water and fire chemistry shatters the strongest locks and expels everything that harms the health of men."*

Lomonosov supported the possibility of comprehending physical, geological and other natural processes with sound and comprehensive arguments. To study nature it was necessary first to discover the essence of the physical particles forming the structure of all bodies.

Voicing his conviction that this task was well within the capabilities of the human mind, he wrote that a man "who wants to examine the nature of the elementary particles that compose all bodies, should strive to discover all their properties and changes, especially those which can be revealed with the help of chemistry which, being nature's closest servant and ally, has access to her innermost depths. When chemistry links together the scattered particles of a solution into solids and gives them different shapes, they should be studied with the help of cautious and astute geometry; when chemistry changes solids into liquids and liquids into solids, and separates or links together various types of matter, it must consult the precise and intricate science of mechanics; when it joins liquids to form diverse colours these should be traced by means of far-seeing optics. Thus, having applied chemistry to analyse nature's properties, and by using geometry to measure the results of his experiments, mechanics to weigh them, and optics to study them visually, the man of curiosity and unflagging zeal will in all probability fathom her secrets."*

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* M. V. Lomonosov, *Complete Works*, Vol. 2, p. 360.

His numerous experiments and theoretical generalisations shedding light on formerly unknown properties and laws of nature have irrefutably proved that the material world is cognisable. He was not daunted by the assertions of Galileo, Locke and other great scientists who alleged that such natural phenomena as heat, light and electricity did not exist outside the perception of our senses and therefore could not be studied by scientists.

Lomonosov was one of those progressive scientists and philosophers who in principle not only agreed that it was possible to comprehend both elementary and compound substances and natural phenomena, but also courageously attacked the most complicated problems which had baffled many of their predecessors and contemporaries. One such problem was the discovery of the nature and interaction of infinitely small particles. Lomonosov wrote that in his age, too, there were scientists "who did set out along this difficult path and made commendable efforts to explore the close-locked secrets of substances and to kindle a light in the midst of all this darkness, but, having failed in their expectations they, apparently, deprived others of almost all hope for success. But any attempt to achieve something great, even if it did end in failure, did not bring them into dishonour. We, too, would not have ventured along this road if we had not considered that by reasoning we could overcome all difficulties, and by adhering to the strict laws of geometry and applying our knowledge of innumerable phenomena in the long run negotiate all the twists and turns and beat a path to the great light of a new and sound philosophy."**

His theories of the origin of heat, light and electricity, besides disproving the subjective point of view on these natural processes, manifest his absolute belief in the power of science and in its ability to solve the most difficult problems of understanding nature. Quite justifiably he declared: "Let no one here speak of seemingly inexplicable phenomena to uphold the opposing side or to overthrow my system, for I shall explain them in due time and thus prove my basic proposition."[*] Further he writes that "elements are the substance of natural bodies, and it is just as essential to learn to understand these elements".[**]

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* Ibid., pp. 353-54.

** Ibid., pp. 459-61.

Lomonosov devoted years of hard work to problems of materialist epistemology. Elaborating his theory of cognition, Lomonosov drew on the achievements of his predecessors, on all scientific propositions, and cast aside obsolete, scholastic and mystical views. The materialist philosophers of the 16th-18th centuries devoted much attention to the problems of the theory of cognition and made considerable headway in elaborating it.

The basic trends in the materialist theory of cognition were empiricism and rationalism. Francis Bacon, the English philosopher and founder of the first trend, believed that man's knowledge of the universe was derived from experiment, and underestimated the role of theory and hypotheses. Bacon's one-sided empiricism, according to Marx and Engels, also caused many of his disciples to arrive at unscientific and even mystical conclusions. Marx wrote that Bacon's "science is *experimental* and consists in applying a *rational method* to the data provided by the senses. Induction, analysis, comparison, observation are the principal requisites of rational method."[***]

Some empiricists exaggerated the role of experiment and being contemptuous of scientific theory fell prey to spiritualism. Engels, who analysed the causes which made a group of natural scientists in England, France and some other countries turn to spiritualism, indicated that one of these causes was their enthusiasm for Bacon's empiricism.

Lomonosov attached great importance to the works of Bacon and other empiricists. He was particularly impressed by their persistent demands to rely on observation and experiment. At the same time, however, he was aware that this method was limited and one-sided and thus manifested the profundity of his views on process of cognition.

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[*] M. V. Lomonosov, *Complete Works*, Vol. 1, p. 135.

[**] Ibid.

[***] K. Marx and F. Engels, *The Holy Family*, Moscow, p. 172.

Rationalism, the second trend in materialist epistemology, was disclosed to the full in the works of Descartes and his followers. Proclaiming that nature in itself is very simple and that its principal attribute is extension, Descartes reaches the conclusion that reason is the chief instrument for attaining knowledge. Thus, according to his conception, "there exists a certain substance which has length, width and depth and all other properties which we know are inherent in it. And this substance which has extension is what we call a body, or a material thing."[*] He believed that sense perceptions could not be a reliable means for understanding matter "for with their help we can only hazard a rare guess about the nature of bodies."[**]

A prominent feature of the Cartesian method was belief in the power of reason, that reason itself was a source of knowledge. Lomonosov had a high opinion of this side of Descartes's rationalism, but maintained that not everything in rationalism was correct or could be applied in attaining a scientific knowledge of nature.

As regards the scholastic theory of cognition, Lomonosov rejected it completely, as did Bacon, Descartes and other great 16th-17th century materialists. He spoke very highly of the efforts of Bacon, Descartes and other West European materialists to refute medieval philosophy, which speculated on the idealist aspects of Aristotle's philosophy.

Descartes correctly observed that there was no better way of proving the falsity of Aristotle's principles than by pointing out that throughout all the centuries they had been in use it had been impossible to make any headway in the cognition of things. Lomonosov criticised scholasticism in similar fashion, but more consistently; he did not mix scholastic philosophy with Aristotle's teachings. Lomonosov appraised Aristotle's philosophy historically and recognised his great services in the development of scientific thinking, but at the same time he vigorously opposed all those who turned the principles of Aristotlian philosophy into absolute, infallible truth, who considered that the great Greek thinker had never erred, never made any unsubstantiated conclusions, etc.

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[*] *Oeuvres philosophiques de Descartes*, t. I, p. 275.

[**] Ibid.

Scholasticism was widespread in mid-18th-century Russia, and Lomonosov lived in its oppressive atmosphere for several years, when he was a student of the Slavonic-Greek-Latin Academy. In subsequent years, too, while working at the St. Petersburg Academy of Sciences, he often came into bitter conflict with supporters of scholasticism. This explains his passionate opposition to scholastic philosophy and firm belief in the correctness of his positions. He strove completely to liberate the Academy of Sciences, the St. Petersburg and Moscow universities and other educational and scientific institutions from the pernicious influence of scholasticism and theology, and it was thanks to his great efforts that materialist theory won firm positions in natural science in Russia.

Lomonosov viewed the development of knowledge as a gradual process of wresting secrets from nature and held that scientists should first assimilate what was already known and only after that move toward new goals. For example, before commencing to build up a new theory of light, he thoroughly studied the works of his predecessors, who had investigated light phenomena, critically assimilating all valuable ideas and rejecting everything obsolete or scientifically unfounded. By this method he solved new problems connected with the further studies of light phenomena and development of a new theory of light.

He bridged the gaps in the old theory of cognition, and magnificently elaborated some fundamental principles of materialist epistemology. One of these principles was formulated as follows: "The best possible way of discovering the truth is to establish theory on the basis of observation, and to introduce corrections into observations on the basis of theory."*

Science, according to Lomonosov, must include both experimental data and theoretical conclusions. "... Today, scientists, especially natural scientists," he wrote, "pay little attention to inventions of the mind alone or empty prattle, but are more inclined to rely on trustworthy experimentation. The natural science of physics now rests almost completely on the latter. Hypotheses are advanced on the basis of reliable and oft-repeated experiments."*

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* M. V. Lomonosov, *Complete Works*, Vol. 4, p. 163.

Scientists must have an all-round knowledge of things to provide any fundamental explanation of the natural phenomena and processes occurring in the material world. Lomonosov proves this point in his definition of the subject matter and goals of rhetoric. He writes that a real orator must be able to throw light on "all things in the universe", and adds that an orator "who has a good knowledge of the present and the past of the world, that is, who is an expert in many sciences, has more material for his eloquence. Any man who would be a finished rhetorician must study all branches of knowledge and science, especially history and moral philosophy."**

Lomonosov held that philosophy, including the theory of cognition, was a real science, whose subject matter and goals were closely bound up with mechanics, physics, chemistry, geology and other departments of knowledge. It is not accidental, therefore, that he frequently called his philosophy natural philosophy. He did not write specific philosophical treatises defining the theory of cognition as a science and setting it apart from other branches of knowledge. According to him cognition was linked by close bonds with natural science. He made this clear by showing that the subject matter of the theory of cognition was related to the problems of physics. In this respect he had every reason to give priority to physics as a branch of knowledge which treats of many natural scientific problems ranging from solid, liquid and gaseous material bodies to various processes occurring in aether. Time and again during his investigations of heat, light and electricity he had to tackle problems of the theory of cognition and other departments of philosophy. Hence, his views on the theory of cognition as a science may be best ascertained by studying the manner in which he defined the subject matter of physics and chemistry and simultaneously disclosed his understanding of the goals of the theory of cognition and its role and place among other sciences.

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* Ibid., Vol. 1, p. 424.

** Ibid., Vol. 7, p. 23.

Examining the relationship between philosophy and physics, Lomonosov placed particular attention on the following: "... a lucid and detailed knowledge of nature acquired by studying natural philosophy, or physics, as it is generally known, will benefit humanity to the highest degree. Physics breaks down compounds, discloses the arrangement of particles forming natural objects, discovers their interaction and connection, and explains their causes. . . ."*

He also made a detailed study of the relationship between philosophy as a whole, including the theory of cognition, and chemistry. This relationship is most vividly stated in his definition of the subject matter of chemistry, the theoretical basis of which was his atomistic theory of the structure of matter. In *Elements of Mathematical Chemistry*, his first original work on chemistry, Lomonosov wrote: "Chemistry is a science of the changes that occur in a compound substance because it is compound."** He realised that this definition covered only what was most important in chemical phenomena. "Undoubtedly," he continued, "many scientists will find this definition inadequate, and will complain that it does not include the principles of division, combination, purification and other terms which might be found in almost all books on chemistry; but those who are more discerning will easily discover that the above terms, with which many authors unnecessarily burden their investigations, may be characterised by the words 'compound substance'. Indeed, a scientist who has acquired a knowledge of a compound substance can explain all the changes that may take place in it, including division, combination, etc.; crude and organic changes such as the crushing and grinding of grain, the growing of plants, the circulation of the blood in a living organism may be excluded."***

In specifying the subject matter of chemistry as a science, Lomonosov divides it into two branches—practical, and theoretical or philosophical. Practical chemistry consists in a "historical understanding of the changes taking place in a compound substance", while theoretical chemistry lies "in a philosophical understanding of the changes taking place in a compound substance".*

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* M. V. Lomonosov, *Complete Works*, Vol. 1, p. 535.

** Ibid., p. 67.

*** Ibid.

He endeavours to fill the gap between practice and theory, and convincingly shows that a scientist who only engages in chemical experiments has not yet fathomed the subject matter of this science and is not a genuine chemist. At the same time he wrote that "those who delight themselves in doing nothing more than deducing conclusions cannot be called real chemists".** He maintained that to make a successful study of the chemical changes taking place in substances, it is necessary to generalise experimental data in theoretical conclusions. He applied this principle in other branches of knowledge, including philosophy. Materialist philosophy and its theory of cognition must also organically combine the results of observations, experimental data and theoretical generalisations. Hence his belief that scientists and philosophers should at the same time be theoreticians and practical men.

Lomonosov examined the subject matter of one or another science in close relation to problem of applying scientific data and conclusions to satisfy the needs of the people. Man's knowledge of the nature of things and natural phenomena could not be limited solely to enriching science with new facts and theoretical conclusions; it should also pursue practical goals. "The study of chemistry," he wrote, "carries with it a double purpose: first—to develop natural sciences; second—to improve the life of the people."*** Once again he turns to chemistry as the best example of how this can be achieved. He attached great importance to the problem of bringing the achievements of chemistry into the life of the population and the country's economy. "Chemistry," he said, "has a broad grasp of human affairs.... Everywhere we can see its successes."**** He went on to define in detail chemistry's role and place in people's lives. He wrote, for example:

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* Ibid., p. 69.
** Ibid., p. 73.
*** Ibid., Vol. 2, p. 459.
**** Ibid., p. 362.

"...chemistry helps us prepare foods and beverages and makes us think of the vessels from which we eat and drink. Their cleanness, transparency, glitter and embellishments, all of which are due to chemistry, doubles the pleasure we experience, for not only the tongue feasts but the eyes, too."*

Chemistry was also used in manufacturing military equipment and Lomonosov wanted to utilise its achievements in this field too in the interests of the people. Thus, he wrote: "Chemistry with its devastating weapons has reduced the danger of mankind's destruction, and by threatening with death has averted the death of many. Rejoice, uninhabited places, stand in beauty, forbidding deserts, for your day is approaching. Look how tribes and peoples are multiplying and settling faster than ever before in new places; soon you will be adorned with great cities and rich villages: you will no longer hear the howling of wild beasts and your expanses, which will be covered with wheatfields and not with thorny bushes as before, will gladden the eye. And when all this comes to pass do not forget to offer thanks to chemistry, your wonderful ally. All it asks in return is that you diligently practice it for your own benefit and enrichment."**

He sought to determine the part played by philosophy in specifying the relationship between chemistry, physics and other natural sciences. Bearing in mind that all processes in the objective world are closely, organically interconnected, it follows that the subject matter of sciences that treat of nature cannot be correctly understood if the links between them are ignored and they are viewed separately. Similarly, it is impossible to understand the subject matter of philosophy and its theory of cognition in isolation from other sciences, for all departments of natural science have common goals, namely, investigation of the nature of bodies and their properties, and application of the accumulated knowledge for the benefit of society.

While examining these questions, Lomonosov formulated many important principles of the materialist theory of cognition. For instance, he substantiated the possibility and necessity of people constantly increasing their understanding of the material world; the principle of unity of observation, sense perception and theoretical conclusions, unity of practice and theory, and so forth.

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* M. V. Lomonosov, *Complete Works,* Vol. 2, p. 365.

** Ibid., p. 367.

Cognition, he maintained, is based on "dependable and cautious experiments to determine the nature and properties of various substances. These experiments suggest theoretical physical conclusions and interpret and determine the causes of the changes and phenomena occurring in nature."*

He consciously upheld and creatively developed the materialist theory of reflection evolved by his predecessors, and understood ideas as the way our mind pictures things or actions.

Unlike many of the scientists who lived before his time Lomonosov advanced lucid and relatively consistent arguments to prove that our sensations and ideas correctly reflect not only nature's common properties, but also the infinite variety of its specific or, as they were called at the time, secondary properties.

His studies of some principles of the materialist theory of cognition were more profound than those conducted by other scientists because they rested both on diverse natural scientific investigations and on a pertinent application of data and conclusions established by linguistics.

He was one of the first in the history of philosophy to determine the place and role of language as a powerful means of communication between people, and an instrument for cognising the surrounding world. In this connection he furnished a new solution for some linguistic problems.

He opens his *Russian Grammar* with a general characterisation of the Russian language as an indispensable means of human communication, and proudly declares that it is in no way inferior to the languages of the advanced European countries. Only foreigners who do not know Russian, he says, or those Russians who are overeager to use foreign languages could doubt the merits of Russian.

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* Ibid., Vol. 1, p. 535.

Lomonosov asserted that the Russian language was developed to such a degree that it could serve as a means for people to communicate their thoughts to each other, describe their activities and so forth, with sufficient clarity. Comparing Russian with Spanish, French, German and Italian, he voices the opinion that it is not inferior to the most developed European languages. That is why, he wrote, "Cicero's powerful oratory, the splendid majesty of Virgil, or Ovid's charming eloquence lose none of their merits in Russian. The Russian language has worthy and expressive means to interpret the most subtle philosophical ideas and discourses, and all the various factors and changes observed in nature and in human society. And if we are unable to describe something it is not because our language lacks the necessary terms and expressions, but because our knowledge of it is inadequate. A wide field, or rather, an all but boundless sea, will unfold before the person who consistently studies it guided by a general philosophical understanding of human speech."*

On the basis of these general propositions he analyses language and the role it plays in the process of cognition. He compares speech with gesticulation and mimicry and underlines the indisputable superiority of the spoken word. Man, he says, differs from animals in that he mentally conceives the words which he uses to convey his thoughts to other people. The role played by language in helping people understand the surrounding world "is as great as the knowledge which it has brought to man". Continuing, he writes: "This knowledge would have been immeasurably limited if each person had his own manner of perceiving things and had not communicated his ideas to others. Before a mechanism is put together all its ready parts are utterly useless for they do not communicate motion to each other. Similarly, if people were unable to transmit their thoughts to each other, we should have been deprived not only of the possibility of co-ordinated action, which depends on co-ordinated ideas; we should have been no better than wild beasts that are scattered in forests and deserts."**

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* M. V. Lomonosov, *Complete Works*, Vol. 7, p. 392.

** Ibid., p. 394.

By developing the Russian language Lomonosov was improving an important means of understanding the objective world and applying accumulated knowledge in the interests of humanity.

Lomonosov firmly adhered to materialist positions in his understanding of the origin and essence of sensations. Lenin, generalising the most important views of materialist philosophers and natural scientists on this question, wrote: "...outside us, independently of us and of our minds, there exists a movement of matter, let us say of aether waves of a definite length and of a definite velocity, which, acting upon the retina, produce in man the sensation of a particular colour. This is precisely how natural science regards it. It explains the sensations of various colours by the various lengths of light-waves existing outside the human retina, outside man and independently of him. This is materialism: matter acting upon our sense-organs produces sensation. Sensation depends on the brain, nerves, retina, etc., i.e., on matter organised in a definite way. The existence of matter does not depend on sensation. Matter is primary. Sensation, thought, consciousness are the supreme product of matter organised in a particular way."* This generalisation is fully applicable to Lomonosov's materialist epistemology.

Like many other 16th-18th-century materialists, Lomonosov considered that a substantial part in the process of cognition was played by sensations. He wrote that a person comes to know nature by means of five organs of sense ("sight, hearing, smell, taste, or touch")**, and that the most diverse material objects and phenomena may be perceived through their agency.

Sensations are aspects of consciousness resulting from the stimulation of our sense organs, and give a basically correct impression of the properties of material objects.

Lomonosov made an interesting and, for his day, a scientifically important effort to explain the nature of sense perception and its relationship to the brain and theoretical thinking. He held that material objects and phenomena stimulate our organs of sense and produce sensations which are transmitted to the brain by means of nerves. However, he oversimplified this intricate process and explained the interaction of sense organs and the brain from a basically mechanistic standpoint. "Through this type of motion," he wrote, "the life-giving juice of the nerves communicates to the brain the changes that take place at their ends when in contact with the outer particles of bodies. It takes an imperceptible period of time for the particles to interact along the entire length of the nerve, from its end to the brain. Because from the laws of mechanics we know that many thousands of such globules or wheels, which are in permanent cohesion with each other, turn when one of their neighbours imparts motion to them, and stop moving when the neighbouring one stops, and thus jointly accelerate or decelerate their motion.

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* V. I. Lenin, *Collected Works*, Vol. 14, p. 55.

** M. V. Lomonosov, *Complete Works*, Vol. 7, p. 103.

"In this way the sour matter, contained in the nerves of the tongue, coheres with the sour particles placed on the tongue and produces a change of motion which is conveyed to the brain."[*]

The important point here is that he endeavoured to explain this process materialistically and did not invoke supernatural forces.

He devoted a great deal of attention to determining the sources of sensations. Developing his predecessors' theories, he offers substantial proof that the material world with its infinite number of properties is constantly stimulating our organs of sense and producing in us the most varied sensations. Lomonosov believed that substances directly stimulating our organs of sense consist of infinitely small particles which have the same properties as the visible whole. "Therefore," he wrote, "when sense organs respond to specific properties they are being stimulated by imperceptible physical particles forming visible bodies...." He added: "...when we perceive through the agency of our senses the different properties of visible bodies, the changes which take place in our organs of sense are produced by the common properties of imperceptible physical particles forming visible bodies; this means that we have sufficient grounds to say that the causes giving rise to specific properties lie in the common properties of imperceptible physical particles forming visible bodies."[*] These discourses offer us sufficient material to give the lie to the falsifiers who claim that Lomonosov rejected the possibility of cognising infinitely small particles through the agency of organs of sense and, consequently, of understanding nature as a whole. Lomonosov never doubted that people could acquire a knowledge and an understanding of the properties of the infinitely small particles making up the microcosm.

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[*] M. V. Lomonosov, *Complete Works*, Vol. 3, pp. 329-30.

Substances and natural phenomena stimulate man's sense of perception first of all because they are in constant motion. As they move, bodies act upon each other, and upon the human organism and on organs of sense. "Internal bodily changes," he wrote, "cannot take place without motion being involved; therefore, the sensations of light and heat which, quite obviously, are changes taking place in sense organs, cannot occur without the movement of aether. Consequently, aether, which easily acquires all types of motion, is really in a state of motion and produces light and heat."[**]

Lomonosov worked at length on the problem of visual perception of light phenomena. Having thoroughly examined the nature of light, and its manifestation in the form of various colours, he reached the materialist conclusion that light, being a special type of motion of a specific material media—aether—stimulates the organs of vision and produces a sensation of light. The organ of vision and its retina are constructed in such a way as to perceive light of various intensity and to discern separate colours. "The retina of the eye," he wrote, "is black so as to permit all colours to combine with it; if a red colour impinges on the eye—red colours are combined, while all others are excluded and are not reflected."[***] This analysis of the manner in which the eye perceives light phenomena demonstrates the limited range of 18th-century knowledge of the physiology of sense organs. The important thing, however, is that Lomonosov's approach to the problem was materialist.

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[*] Ibid., Vol. 1, pp. 307, 309.
[**] Ibid., Vol. 3, p. 287.
[***] Ibid., Vol. 1, p. 137.

His views on other sensations are likewise based on the materialist theory of reflection. This is how he describes the material source of the sensation of heat: "...when a hand feels the heat of a substance, the particles of the cohering matter of the hand begin to rotate faster; whereas a sensation of cold slows down their motion."* To be sure, this explanation of the source of heat, like his explanation of other sensations, reduces the intricate relations between the material object impinging on sense organs and the sensations themselves to simple mechanical ties, to mechanical motion. But at the time such a solution to this problem necessarily furthered the development of scientific cognition of the more complex connections and general laws of natural phenomena.

Just as thoroughly Lomonosov examined the nature and character of sound phenomena. He was firmly convinced that sounds exist objectively, outside the human mind, and that the sensation of hearing is a more or less correct reflection of real sounds. He explained this problem in the following way: "Sound spreads by means of the oscillatory motion of atoms. But, according to our theory of reflection, resiliency is also produced by similar random motion. Therefore we might be asked why we do not hear some sort of a continuous sound produced by the endless motion of the atoms of resilient air. Our reply to this question is that sound is perceived by the eardrum, which is brought into motion by the force of air; but the sensation of sound is absent when the eardrum is in a state of rest. The eardrum remains in a state of rest when the oscillation of the air filling the inner and outer sections of the cavity which it divides into two is equal. The sensation of hearing is aroused when this equilibrium is disturbed and the external side of the membrane is subjected to stronger oscillations of the air than its inner side. Hence, when an empty vessel is brought close to the ear, the oscillations of the atoms of the resilient air rebounding from the solid walls of the vessel concentrate and impinge on the eardrum with greater force than the atoms confined in the internal cavity, behind the eardrum itself, thus setting the latter into motion and producing a vague sound in the ear. Considering that this sound is always perceived when a hollow object is brought close to the ear, it is evident that the atoms of the resilient air are in constant oscillatory motion."*

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* M. V. Lomonosov, *Complete Works*, Vol. 2, p. 25.

Lomonosov maintained that there is an immense diversity of sounds in the world which impinge on the ear primarily through the movement of the air. "One can easily imagine the number of sounds that exist in the world," he wrote, "if we take into account the various musical tones of different intensity produced by all sorts of musical instruments; the great diversity of whistling, squeaking, ringing, rustling and other sounds caused by friction, collision and breaking of bodies; the voices of men and animals, which are so different that we can discern not only the voice of a friend among thousands of other voices but also distinguish one dog from another by its bark; and finally, the articulate words of all the numerous languages of the world. Nevertheless, no physicist doubts that all these sounds are caused and spread by the oscillatory motion of the air."**

In considering Lomonosov's ideas about sense perception it should be noted that he did not regard sensations in isolation from one another, but held that there was a definite relationship between them. "Smells which stimulate our sense of smell," he wrote, "are more often than not connected with tastes; for example, that which has a sour taste stimulates a sour smell in our nose. Our definition and characterisation of the infinite variety of smells should be based on the same principles as our characterisation of tastes."***

Some natural scientists and philosophers, emphasising the limited capabilities and the imperfection of human organs of sense, concluded that man had a very limited knowledge of nature and that people could not discover the essence of the surrounding world.

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* Ibid., Vol. 2, pp. 135, 137.

** Ibid., Vol. 3, p. 295.

*** Ibid., Vol. 2, p. 503.

Lomonosov opposed this brand of agnosticism. Although he agreed that man's organs of sense can directly perceive only some of the properties of the infinite variety of substances and natural phenomena he, nevertheless, sought to prove that in principle everything in the surrounding world is knowable. He buttressed this viewpoint with the irrefutable argument that man's organs of sense can be illimitably sharpened with the help of various measuring instruments. "...The microscopes invented in recent ages," he wrote, "have sharpened our vision to such an extent that we can distinguish many particles of a tiny speck of dust. But these useful instruments are used to examine only organic particles—the extremely small globules and tubes which are invisible to the naked eye—making up the solid parts of animals and vegetables. At the same time microscopes are incapable of revealing to the eye particles which make up compound substances."*

He believed that with the help of microscopes people would be able to examine bodies thousands of times smaller than the tiniest of objects visible to the naked eye, and that eventually it would be possible visually to study even the infinitely small particles which were called insensitive at the time. One of his brilliant discourses on this epistemological question runs as follows: "...chemistry tells us that cinnabar contains mercury and that quartzes contain alumina, but even the most powerful microscopes are unable to detect their presence.... Here, I imagine, you will say that chemistry treats only of matter forming compound substances and not of each particle of which they are composed. But if this secret should ever be disclosed it will be due primarily to chemistry, which will be the first to raise the veil hiding this sanctum of nature."**

He did not confine himself to theoretically substantiating the epistemological proposition concerning the possibility and the necessity of assisting man's organs of sense with various instruments but invented new instruments and improved the existing ones. The works of S. Vavilov, V. Chenokal, and other Soviet scientists contain a detailed analysis of Lomonosov's contribution to the development of various scientific devices and measuring instruments. Lomonosov himself frequently mentioned that he had to spend a great deal of time and effort to invent new and improve old scientific instruments. In a report to the Academy on this work in 1759 he wrote:

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* M. V. Lomonosov, *Complete Works*, Vol. 2, p. 352.

** Ibid., pp. 352-55.

"1. I have compiled and publicly delivered a discourse on the great accuracy of marine navigation, and for this purpose I have invented new instruments, which have been made under my personal supervision.

"2. I have invented a new functioning universal barometer for registering changes in pressure.

"3. With the help of the centroscopic pendulum I have invented and the above-mentioned universal barometer, I have observed 2,100 changes previously unrecorded by scientists.

"4. I have invented a new instrument for observing stars along a single vertical line which does away with the difficult division of quadrants into degrees and minutes.

"5. I have conducted experiments to discover optical means for seeing further through water than it is possible with the naked eye."*

He attached great importance to acquiring a knowledge of the nature of the processes taking place in outer space. For this purpose he spent a great deal of time improving the telescope and other optical instruments. In 1762 he informed the Academy that he had invented a new catadioptrical glass which he described in detail in his *Notes on Chemistry and Optics* and *On the Improvement of Spy-Glasses:* "...my newly-invented catadioptrical glass is better than Newton's because 1) it is easier to manipulate owing to the absence of the small mirror and, therefore, 2) it is cheaper to manufacture, 3) it is constructed in such a way that nothing stands in the path of the large mirror and permits the entry of more light, 4) it is more durable, particularly during travels, than the above-mentioned glasses, 5) the sun's rays do not lose their intensity or become diffused in the small glass (which I have left out of the design as an unnecessary element), thus making for greater light and clarity, and, 6) the new white coating covering the back of the mirror tends to increase the intensity of light."[*]

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* Ibid., Vol. 10, p. 395.

In 1756, Lomonosov reported to the Academy: "I have invented a new optical instrument that I have called a nyctoptical glass (*tubus nyctopticus*) which makes it possible to see in the darkness of the night. The first test has revealed that by looking through this glass during twilight hours one can discern objects unobserved by the naked eye. Let us hope that skilled craftsmen will eventually improve it to the present level of telescopes or microscopes, which were also once very primitive."[**] The principle underlying the design of Lomonosov's nightglass has retained its scientific importance to the present day. Academician Vavilov in a special paper treating of this outstanding invention, wrote: "Lomonosov conducted practical experiments with the nightglass during the night and took into account all the accompanying difficulties and all the peculiarities of seeing at night. He did not err when he intuitively guessed the specific factors of the enlargement produced by the glass during observation at night.

"All-round tests of spy-glasses, binoculars and other telescopic systems in night conditions were not carried out until quite recently at the optical institutes of Paris and Leningrad and revealed a very intricate relationship when the object under observation changed in brilliancy or contrast."[***]

What Lomonosov had to say about the unlimited possibilities for inventing, perfecting and developing various optical and other instruments designed to assist man's organs of sense has been fully substantiated by scientific and technological progress.

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[*] M. V. Lomonosov, *Complete Works*, Vol. 4, p. 407.

[**] Ibid., Vol. 10, p. 393.

[***] S. Vavilov, *Complete Works* (Russ. ed.), Vol. III, U.S.S.R. Academy of Sciences Publishing House, Moscow, 1956, pp. 670-71.

All this shows his materialist positions in assessing the role and place of sensations in the process of cognition. He considered that sensations were the sole source of our information about the world and supplied us with data for theoretical conclusions. In his *Thesis on Solidity and Fluidity*, he seeks to determine the configuration of bodies in heat phenomena, basing his deduction on sense perception.

He maintained that there should be no discrepancy between our sensations and the properties of substances which stimulate our organs of sense.

Similarly, he considers that sensations and the role they play in assisting man to acquire a knowledge of nature are intimately bound up with experimentation and its great part in furthering science. In this question too, he carried forward the traditions of preceding generations of scientists. "I hold," he wrote, "that one experiment is worth a thousand opinions based on imagination alone."

As we have already pointed out Lomonosov was one of the founders of experimental natural science in Russia. Moreover, he performed a great service to science by organising and carrying out experimental investigations in the most diverse branches of natural science. For many years he experimented in his laboratory of minerals and metals, and up to 1748 conducted experimental studies in physics, during which he elaborated his theory of heat and other physical principles.

Lomonosov embarked on large-scale chemical experiments after 1748, when the St. Petersburg Academy had established Russia's first chemical research laboratory. He rightly maintained that not all experiments were of importance to science, and that it was necessary to conduct only those which were closely bound up with scientific problems. He considered it imperative to experiment in conformity with the requirements of physics. The number of experiments should not be unlimited. A scientist should not carry out more experiments than required to solve a definite problem. Lomonosov recommended a definite logical continuity in this respect, namely, from simple experiments to more complicated ones. During experimentation it was important to take into account the results of daily practical work. He did not confine himself to laboratory experimentation alone, but insisted that its results be introduced into production processes. This was borne out by the close links connecting his laboratory experiments with the organisation of glass production at the Ust-Ruditsk factory.

Lomonosov warned against absolutising sensation, although he was a confirmed adherent of the materialist proposition that sensations, as a rule, correctly reflect the existing properties of material objects. He considered that the organs of sense convey a correct impression of the external properties of substances, and underlined, for example, that in determining the relationship between heat and light, it is impossible to rely exclusively on our sense perception.

Lomonosov comes close to the correct conclusion that sensations alone do not convey a sufficiently accurate impression of the surrounding world, although they are stimulated by the interaction of the sense organs with extraneous natural phenomena. But, not knowing the physiological factors causing deviations from the accepted rule that a person obtains an absolutely correct impression of an object through the agency of one or another of his senses, he was unable to explain these deviations.

Finally, he understood fairly well that no scientist who relies on the evidence of his senses alone could fully comprehend the results of his experiments, or use them to acquire a knowledge of the nature of material processes. He asserted, for example, that "those who seek to obtain the truth from experiments with the help of nothing more than their senses usually learn nothing: for either they do not notice the finest, essential points, or else they fail to make use of what they see or perceive through the agency of other senses."*

The conclusion is that in the materialist theory of cognition Lomonosov had made an important step forward on the road to surmounting the one-sided and limited nature of empiricism. He caustically criticises empiricists who occupy themselves "solely with practical chemistry and do not dare raise their heads above coals and ashes" and, therefore, cannot understand the nature of substances and their infinitely small particles. At the same time a knowledge of these particles, he says, "is just as essential to physics as the elementary particles are essential components of sensitive bodies."*

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* M.V. Lomonosov, *Complete Works*, Vol. I, p. 125.

Lomonosov did not belittle the importance of studying the external qualities and peculiarities of objects and natural phenomena. Nevertheless, he considered that such knowledge was inadequate and superficial and that it was necessary to ascertain the essence of things, to disclose the relationship linking their inner properties, to discover the general laws governing the appearance and development of this relationship, etc. "Does not the man who has taken a clock to pieces and examined the excellent and pleasing shapes of its parts, and their proper arrangement, their interconnection and the very cause of their motion, does not he enjoy its beauty more, is he not more sure of its constant functioning, more confident of the time it shows, more deeply surprised by its cunning design and louder in his praises of the maker than he who sees only the outward appearance of this machine, knowing nothing of its inner construction? Likewise, he who knows the properties and motion of the small parts that make up sensitive bodies, and has investigated the disposition of the organs and the laws of motion sees nature like a dancer performing before him without concealment of her art. He sees how nature, though all but murdered by the winter's cold, awakens the trees to life in spring, how she enriches summer with harvest and fruit and prepares seeds for the future, how by day and night, she lessens and increases heat and cold, sends and stills the winds, makes rain to fall, ignites the lightning and frightens mortal men with thunder, regulates the flow of rivers and performs other wonderful acts; how much more joy has he than that man who looks only at the outward semblance of things and instead of the things themselves perceives but their shadow. He who puts these thoughts on nature into effect in civil or domestic enterprises, will have firmer and more joyful hope of an auspicious end to his undertakings, and will have the greater satisfaction from their completion the more clearly he perceives the secret and zealous forces of nature at work in all things."*

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* Ibid., Vol. 3, p. 342.

For Lomonosov senses, perception, observation, and experiment were not the only means of cognition, but a necessary link in the process of cognition.

The second and no less important link in this process is theoretical thinking. A scientist can unlock nature's greatest secrets only by combining the data obtained through the agency of his senses, the results of his experiments and his theoretical conclusions. According to Lomonosov direct observations produce but "simple ideas" in the mind, whereas thinking gives birth to sound scientific theories promoting a more profound understanding of the phenomena and substances observed in nature and the general laws governing her changes. Taking issue with the empiricists, he wrote: "Why have scientists conducted such a large number of physical and chemical experiments? Why have so many of them worked hard and risked their lives to carry out dangerous experiments? Do not tell me that it is only for the sake of gathering a vast amount of information, piling it up into a shapeless heap and looking and wondering at it without thinking of its arrangement or endeavouring to give it any system.** It was only by combining experimental data with versatile theoretical generalisations, that Lomonosov, for example, created a theory of heat, which was for his day quite consistent. The empiricists, unable to rise to the level of deep-going generalisations, did not appreciate this great scientific achievement and subjected him to unfounded attacks. His theory of the origin of heat elicited indiscriminate criticism in the German magazine *Commentarii de rebus in scientia naturali et medicina gestis*. This magazine, completely committed to its empirical positions and denying the importance of theoretical conclusions, alleged that

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* M. V. Lomonosov, *Complete Works*, Vol. 1, p. 534.

** Ibid., Vol. 3, p. 342.

Lomonosov did not base his new theory on facts or experiments. Citing an excerpt from the magazine to the effect that "Mr. Lomonosov wants to attain something more than simple experiments", Lomonosov wrote: "As though a natural scientist really has no right to overcome the routine method of experimenting and is not called upon to deliberate over their results and then turn to making discoveries. Is it actually the lot of a chemist, for example, all his life to hold pincers in one hand and a crucible in the other and never for a moment step away from coal and ashes?"[*]

Developing this idea, he wrote that people who deny the possibility and the necessity of designing scientific theories will always roam in the dark and conduct aimless observations and experiments. He justifiably noted: "If we cannot elaborate theories, then what is the purpose of so many experiments, or all the efforts and hard work put in by great scientists."[**]

He made a fairly clear distinction between experiments on the one hand, and theoretical generalisations, on the other. He considered that the main purpose of experimental chemistry was experimentation supplemented with either direct or indirect deductions from those experiments, while the goals of theoretical chemistry were to discover the essence and the general laws of chemical phenomena.

For the 18th century his works on heat, light and colours, electricity, and geological processes were brilliant examples of creative application of the fundamental principles of the materialist theory of cognition in the solution of new scientific problems. This is how he described his work on the theory of physical chemistry: "Since the establishment a little over 12 years ago of the Academic Laboratory well-equipped for conducting chemical experiments under my supervision, I have not only lectured on and carried out the usual experiments employed in investigating the composition of substances, but also made every effort to study everything that might be determined with the help of the laws of geometry and physics, and applied new methods of investigation, thus opening the way for the creation of physical chemistry."[*]

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[*] Ibid., p. 220.

[**] Ibid., Vol. 3, p. 239.

He followed the same line in his brilliant work *On the Layers of the Earth*, in which he outlined the basic problems of metallurgy. "If we, who live on the surface of the Earth, were able to see what lies beneath it," he wrote, "we would do everything in our power to penetrate as far as possible into its farthest depths."[**] He maintained that this problem could be solved only with the help of theoretical generalisations. "It is a great thing," he wrote, "to penetrate with your mind the depths of the Earth, which nature has placed beyond the reach of your hands and eyesight, to travel through the subterranean regions in your imagination, to fathom the narrow fissures with your reasoning and to bring to light all the things and phenomena that are hidden in the darkness of eternal night."[***]

His works contain many propositions about the essence of scientific thinking, ideas and concepts and the part they play in the process of cognition. His analysis of this problem shows him to have been an outstanding proponent of the materialist theory of reflection. He attached scientific value only to those ideas, concepts or theories which correctly reflected the actually existing substances and phenomena and their properties.

In contrast to sensations which originate as a result of the direct influence of substances on organs of sense, ideas, Lomonosov wrote, are "impressions of things and motion conceived in our minds. For example, we have an idea of a clock when we either see it or imagine it in our minds, similarly we have an idea of motion when we either see or imagine a thing that is constantly changing its location."[****] When a person is making a theoretical generalisation, he perceives in his mind that which "is hidden from our senses by time, distance, or the size of the great bodies, or whose properties are so fine that our senses cannot corroborate them".[*****] Besides people can imagine not only a body, but also the conditions in which it exists. "Man," Lomonosov writes, "possesses the power of imagination which is an inward quality permitting him mentally to conceive an object simultaneously with other related things or objects; for instance, a person who forms a mental image of a ship also creates in his mind the image of the sea on which it is sailing, the image of the sea is associated with a storm, a storm with waves, waves with the sound of breakers, breakers with rocks, and so forth."* With the help of senses and experimental data man's mind "breaks down compounds, perceives the arrangement of particles forming material bodies, understands their interaction and relationship and deduces the causes of this relationship".** But the mind, he went on, did not create the substances themselves. Quite consistently for the time, Lomonosov upheld materialist positions with regard to this problem. For instance, he considered that in the controversy between the nominalists and the realists, the positions of the nominalists were more correct. The realists, he wrote, asserted that "the names of objects conveyed a knowledge of the objects themselves. This led to the formation of a new sect of scientists calling themselves nominalists (*Nominales*). Thereafter, bloody disturbances and clashes took place in Paris between students of the nominalistic trend and those holding opposite views, who called themselves realists (*Reales*). I believe that we should not use words accepted at random, but those which reflect ideas and actually existing objects and motion, and which to some degree are related both to the theme under discussion and among themselves."***

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[*] M. V. Lomonosov, *Complete Works*, Vol. 3, p. 443.

[**] Ibid., Vol. 5, p. 530.

[***] Ibid., pp. 530-31.

[****] Ibid., Vol. 7, p. 100.

[*****] Ibid., Vol. 1, p. 535.

Lomonosov applies the materialist theory of cognition in his works, particularly in *Rhetoric* and *Russian Grammar*. Ideas, he says, may be either simple or complex, depending on what they reflect. Simple ideas reflect one phenomenon, complex reflect two or more phenomena. Thus the concept "night", according to Lomonosov, is a simple idea, but the concept "at night people rest after work", is a complex idea, for it expresses several concepts. The grouping of material bodies and phenomena into specific families, species, classes, etc., must also be reflected in concepts. "An assembly of many of a species," he wrote, "is frequently conceived in our mind as a simple concept for in it we have a common noun which we call a *collective* noun, such as *regiment, council, forest, herd*."[*]

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* Ibid., Vol. 7, p. 109.
** Ibid., Vol. 1, p. 535.
*** Ibid., Vol. 7, p. 116.

The greater our knowledge of nature, the greater the number of new ideas, concepts and theories, and the more perfect and complicated language with its ever increasing number of words becomes. At the same time concepts are formed which express a common property of a large number of bodies or phenomena. At first, Lomonosov pointed out, we conceived every object separately and only after that did we begin to develop collective concepts. He describes this aspect of the process of thinking in the following words: "Our mind pictures things according to their number, that is, either one or many. Here, too, man manifests his inclination to shorten words, for otherwise, having named an object, we should have to repeat the same name many times in order to convey the concept of a large number of these objects. For example, we would say *stone*, meaning one stone, and *stone*, *stone*, *stone, etc.*, meaning many stones. But a shorter way has been found to denote the plural and not by tedious repetition of the same word, but by a small change of the last letter of the word—*stones*."[**]

Lomonosov tied up his analysis of the role of abstract thinking with a study of the origin of language and its importance in the development of knowledge. He viewed words and the rules governing their relationship and arrangement into phrases and sentences from the standpoint of the materialist theory of cognition. "Words," he wrote, "are given man to enable him to communicate his ideas to others.... Words by which things are known are called nouns, while words describing actions are called verbs.... Since these words always describe a thing or action, they may be legitimately called *denominative parts of speech*."[*]

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[*] M. V. Lomonosov, *Complete Works*, Vol. 7, p. 409.

[**] Ibid., p. 410.

The various words in a sentence describe the actions and interconnection of things. Since things and their actions exist in nature they should be correctly described by the concepts and ideas expressed in words. Things change with time and, consequently, there should be words to describe these changes. "Verbs," he points out, "describe action, the primary factor of which is time. Time is divided by nature into three periods—the *present*, the *past* and the *future*—for a man communicating his ideas to another speaks of what is taking place at present ... what took place in the past ... what will take place in the future."[**]

Words describing the properties of bodies also have their peculiarities, but inasmuch as properties without bodies do not exist, adjectives have no sense without substantives. "We mentally conceive things together with their properties", but since "properties cannot exist without bodies" it follows that "nouns describing the thing itself are called *substantives*..."[***]

Lomonosov attached exceptional importance to the role played by theoretical conclusions in the process of cognition of nature and created several new natural scientific theories. Elaborating them and other problems he paid a great deal of attention to hypotheses. Before creating a theory a scientist conjectures and prognosticates so as not to grope his way in the dark. But there were many 17th-18th century scientists, particularly empiricists, who underestimated hypotheses and even denied their importance to science. Newton, for example, used to say that he did not make hypotheses (*hypotheses non fingo*). By hypotheses he meant anything that could not be deduced from a certain phenomenon and, therefore, had no place in philosophy.

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[*] Ibid., p. 406.
[**] Ibid., p. 414.
[***] Ibid., p. 409.

Nevertheless, Newton relied on hypotheses on more than one occasion when working on scientific problems.

Lomonosov openly and directly upheld scientific hypotheses. Arguing against the empiricists, he wrote that a scientist "should not be in a hurry to condemn hypotheses. They are accepted in philosophical subjects and have sometimes been the only way in which the greatest of minds could proceed to the discovery of the most important truths. A hypothesis is a kind of inspiration, making it possible to achieve knowledge that is out of reach of mean minds and those who grovel in the dust".*

His own works magnificently sustain the enormous role played by scientific hypotheses in the process of cognition of the material world.

Very frequently during work on new scientific problems he would first advance a hypothesis resting on very slim facts, and then, after checking and substantiating it with further laboratory investigations, endeavoured to develop it into a scientific theory. Hypotheses proved to be of immense importance when he sought to discover the origin of the particles making up the microcosm. The 18th-century measuring instruments were too weak to permit direct observation of atoms or molecules. They could be judged only by the properties of bodies that were perceived by the senses. Lomonosov advanced the hypothesis that the properties of bodies were not only dependent on the properties of these particles, but also that it was possible to judge of the properties of elementary particles by the properties of the whole body.

His reasoning concerning the shape of elementary particles is of considerable interest. Examining the origin of heat, light and electric phenomena he arrives at the very important conclusion that these phenomena are caused by various types of motion of infinitely small particles. This made it essential to establish their interaction in the process of motion, the manner in which one particle communicates its motion to another, and so forth. By drawing an analogy between the mechanistic interaction of visible bodies, he evolves the hypothesis that most probably these particles are spherical in shape. Here is one of his discourses on this question: "Nature manifestly prefers spherical forms in both the biggest and the smallest bodies. This is borne out by the shape of the immense heavenly bodies and the tiny globules floating in the blood. What shape other than round is more often observed in various parts of animals and vegetables, in eggs, fruits or grain. As regards fluid substances, not excluding molten metal, they always tend to assume the form of spherical drops, which are all the more round the smaller they are. The above would have been enough to substantiate the idea that elementary particles are also round, but we do not lack more convincing arguments making this even more obvious. We should not be deterred by the apprehension that there could not be such an infinite variety of things if they did not allow of a variety of beginnings, for the differences in size, position or place suffice to explain this variety."*

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* M. V. Lomonosov, *Complete Works*, Vol. 3, p. 231.

Many scientific hypotheses framed by Lomonosov have been fully substantiated in the course of the development of natural science and philosophy.

In his theory of cognition he maintained that observations, laboratory experiments and theoretical generalisations should be closely bound up with practice and their results applied in production. By learning to understand nature man not only displays the strength of his intellect, which is capable of discovering the hidden properties of bodies and material processes, but also improves the well-being of people. It is obvious, he wrote, that "a lucid and detailed knowledge of nature acquired by studying natural philosophy or physics, as it is generally known, will benefit humanity to the highest degree."**

He was the first man in Russia to link science with production and apply scientific achievements in industry, agriculture, trade and everyday life. He advanced a series of scientific proposals on how to combine science with production, and brilliantly demonstrated by his own practical work how a scientist and a patriot should dedicate himself to serving his people and thus improving their well-being.

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* Ibid., pp. 222-23.

** Ibid., Vol. 1, p. 535.

His thoughts on linking science and production and many other progressive ideas were buried in oblivion by Russia's reactionary ruling classes. It is only since the October Revolution that his best traditions have been revived and are being successfully put into practice.

On November 18, 1936, *Pravda* carried an article marking the 225th anniversary of Lomonosov's birth which said in part: "The source of Lomonosov's energy was his extraordinary thirst for a scientific knowledge of life and his desire to transform his country. For him science was directly connected with experimentation, practice, the industrial exploitation of Russia's natural resources. He had a deep love for his people. That was why he waged such an uncompromising struggle against scientific nonentities, against closed groups of scientists locked up in the narrow circle of their own interests."

Such an understanding of the subject matter and the goals of sciences were mirrored in his theory of cognition. He formulated the general principle of the unity of theory and practice in the following words: "The knowledge obtained through studies is divided into sciences and arts (the latter meaning production—*Ed.*). Sciences give a clear understanding of things and causative action and properties; arts use scientific achievements to improve man's well-being. Sciences serve to satisfy our inherent inquisitiveness; arts make our lives merrier by the benefit they bring us. Sciences open the road to arts; arts stimulate the emergence of new sciences. Both concordantly serve a common cause. And both clearly show the importance of chemistry in investigating nature and developing arts."*

He sought to apply the principle of unity of theory and practice in almost all branches of natural science. We should stress here that by "practice" he meant first and foremost tests, observations, and the production of useful material objects. It is known that the old materialists had a one-sided view of practice and, as a rule, reduced it to a passive contemplation of nature. They maintained that nature was immutable and consequently man could not change anything by his intervention. Lomonosov wanted to step beyond this historically limited understanding of nature. He held that it was possible to transform nature and believed in man's strength and in his ability to subject the elements of the surrounding world to his will.

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* M. V. Lomonosov, *Complete Works*, Vol. 2, pp. 351-52.

Man, he believed, could influence natural phenomena and processes provided he had a knowledge of bodies and the infinitely small particles forming them. While investigating the changes taking place in nature man should reproduce these changes in laboratory experiments and in production on the basis of the general laws of natural processes. In the laboratory which was fitted out under his supervision and, afterwards, at the stained-glass factory Lomonosov personally performed an immense number of experiments with a view to obtaining new chemical substances essential for the satisfaction of human needs. Convinced that any man who had a knowledge of the properties of bodies could change these properties artificially to obtain useful substances, he solved many important practical problems by means of laboratory experiments. In 1754 he wrote to Leonhard Euler: "For three years I have been immersed in physico-chemical experiments for the purpose of evolving a science of colours. And I have not worked in vain, for apart from the results obtained from experimenting with various mineral solutions and precipitations, the almost 3,000 experiments that I have conducted in order to reproduce various colours in glass have yielded not only an enormous amount of data for elaborating a genuine theory of colours in glass, but have also made me start the production of mosaic."*

Lomonosov's opinion was that the history of chemistry offered sufficient proof that more and more new useful substances could and should be produced synthetically. But he was distressed that not all substances obtained by chemists served the needs of society and sometimes were used only for selfish gain. He dreamed of turning chemistry and other sciences into an instrument for improving the life of the people and promoting progress. Having expounded in some detail his theoretical propositions regarding the origin of metals and minerals, and bearing in mind the works of other prominent scientists, he reached the conclusion that all this could be a dependable practical guide in prospecting and utilising mineral resources.

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* Ibid., Vol. 10, p. 502.

Lomonosov theoretically concluded that there was a northern passage leading from west to east in the Arctic Ocean and played an important role in opening it. The discovery of the Northeast Passage was of vital importance for Russia. In spite of its giant size Russia was making little use of the sea routes across the Baltic and in the White Sea to develop her military power and trade. Her inadequate transport facilities made overland communications extremely difficult and expensive. Accordingly, Lomonosov, who had known the White Sea and the Arctic Ocean from childhood, decided to provide sound theoretical arguments for developing the Northeast Passage to meet Russia's economic and military interests. Russian renown could be "considerably enhanced" by developing a Northern Sea Route and there would be "unprecedented gain from acquiring north-east navigation to India and America".*

While working on this plan and searching for practical ways to implement it, he encountered much opposition from his enemies in the scientific world. He knew that it would be very difficult to master the Northeast Passage but at the same time he was fully aware of the great benefits it would bring. "Russia," he wrote, "whose northern shores, for the most part explored and described, are washed by the waters of the Arctic Ocean, makes no effort to seek a way to her eastern shores where no foe could threaten her and she could build towns and station her fleet in safety only because of the ice and the cold. The Russians should not undertake long sea voyages through various climatic zones ranging over 70°, but follow the route that passes between 80° and 65° north latitude. In the northern seas they will not encounter squalls or thunderbolts nor will they have to endure long spells of calm and intense heat that bring on pestilence and drive men to madness, and cause their food and water supplies to rot. All this will be prevented by the cold which people dread so much."*

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* M. V. Lomonosov, *Complete Works*, Vol. 6, p. 420.

Lomonosov applied the principle of unity of theory and practice to astronomy. Mechanics, physics, geology and metallurgy help scientists acquire a knowledge of natural substances primarily for the purpose of using them to satisfy the requirements of the people, while astronomy, a science which treats of the heavenly bodies, helps man obtain his bearings on land and sea. The development of stock-raising, farming, navigation and so on, also required a certain knowledge of astronomy which, in its turn, played an important part in geographical discoveries and consequently in the development of new lands and natural wealth for the benefit of society. This was what Lomonosov had in mind when he asserted that "a thorough knowledge of the movement of the heavenly bodies greatly benefits humanity, especially navigation, as is shown by the discovery of the sea routes to India and America and around the world. The importance of these discoveries cannot be overestimated".** In his *Brief Account of Journeys on Northern Seas and Demonstration of the Possibility of Sailing to the East India via the Arctic Ocean* and *Tentative Instructions to Naval Officers Setting Out in Search of a Passage to the East Across the Arctic Ocean*, he describes the connection that astronomical observations and theoretical generalisations have with practical navigation, including the realisation of his grandiose plan for discovering the Northeast Passage.

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* Ibid., Vol. 6, pp. 424-25.

** Ibid., Vol. 4, p. 337.

Lomonosov held that all branches of knowledge should be placed at the service of society and play an active role in solving vital practical problems.

His propositions concerning the unity of theory and practice constitute one of the most important aspects of his world outlook and a fine tradition that is particularly close to Soviet science. Academician S. Vavilov pointed out that one of the basic features of Lomonosov's philosophy was the amazing way in which all his work was bound up with practical requirements.

Chapter VI

ELEMENTS OF DIALECTICS IN LOMONOSOV'S WORKS

Lomonosov lived and worked at a time when the metaphysical view on nature dominated natural sciences and philosophy. Though they put forward a great number of hypotheses, theories and systems, the materialist philosophers and scientists of the period were at one in entertaining a "peculiar general outlook, the central point of which is the view of the absolute immutability of nature".* Most scientists and philosophers maintained that "in whatever way nature itself might have come into being, once present it remained as it was as long as it continued to exist".** Generally speaking, Lomonosov did not transcend the limits of this philosophy.

It should be borne in mind that in the 18th century the metaphysical method of cognition in natural science and materialist philosophy was still a progressive method. Marx and Engels on the basis of a profound analysis of the history of society, including the history of scientific thinking, showed that the metaphysical method became a necessity at a certain stage of scientific development. This is particularly true of science in the 17th and 18th centuries. In order to obtain a profound knowledge of nature and the general laws of its development, it was necessary first to study in detail separate objects and their properties, and only after that establish theories which might more thoroughly disclose the origin of bodies and phenomena, their endless change, their intricate and varied interconnections and interactions, etc. Engels wrote: "The analysis of nature into its individual parts, the grouping of the different natural processes and objects in definite classes, the study of the internal anatomy of organic bodies in their manifold forms—these were the fundamental conditions of the gigantic strides in our knowledge of nature that have been made during the last four hundred years. But this method of work has also left us as legacy the habit of observing natural objects and processes in isolation, apart from their connection with the vast whole; of observing them in repose, not in motion; as constants, not as essentially variables; in their death, not in their life. And when this way of looking at things was transferred by Bacon and Locke from natural science to philosophy, it begot the narrow, metaphysical mode of thought peculiar to the last century."* But with man's accumulating knowledge of things and the appearance of new sciences as a result of the development of productive forces and technical progress, the limited nature of the metaphysical method became more and more of an obstacle to scientific progress, although it was less so for scientists who worked in narrow, restricted branches of science.

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* F. Engels, *Dialectics of Nature*, Moscow, 1966, p. 24.

** Ibid.

For investigators of the Lomonosov type, who sought to give an integral scientific picture of nature, this method developed into a serious impediment. He devoted his entire theoretical activity to elaborating a scientific system of knowledge of nature as a single whole. In the draft plan of his *System of the Whole of Physics*, drawn up towards the end of his life, he shows how he had intended to solve this problem. Here are some of the points of this plan: "Extraordinary concord, strength; harmonious series of causes; unanimous legion of arguments"; "harmony and concord of all causes is the most constant law of nature", "everything is linked together by the single force and harmony of nature".**

Lomonosov was making brilliant efforts to step beyond the metaphysical method of cognition. Dialectics was making itself felt both in natural scientific theories shedding light on one or another aspect of the development of nature, and in the philosophical generalisations that rested on these theories.

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* F. Engels, *Anti-Dühring*, Moscow, 1962, p. 34.

** M. V. Lomonosov, *Complete Works*, Vol. 3, p. 493.

In the middle of the 18th century scientists in the West-European countries started making the first serious attempts to transcend the limits of the metaphysical outlook in natural science and philosophy. In this connection Engels particularly emphasised the Kant-Laplace hypothesis on the origin of the solar system. "Kant," he wrote, "began his career by resolving the stable solar system of Newton and its eternal duration, after the famous initial impulse had once been given, into the result of a historic process, the formation of the sun and all the planets out of a rotating nebulous mass. From this he at the same time drew the conclusion that, given this origin of the solar system, its future death followed of necessity. His theory half a century later was established mathematically by Laplace, and half a century after that the spectroscope proved the existence in space of such incandescent masses of gas in various stages of condensation."* The appearance of this hypothesis, which organically combined scientific data on the origin of the solar system and daringly original philosophical conclusions, made the first breach in the metaphysical mode of thought.

It should be mentioned that Lomonosov expounded several admirable ideas about the variability of nature which dealt a blow against the metaphysical world outlook even before Immanuel Kant had written his *General History of Nature and Theory of the Heavens.*

Lomonosov's general law of the conservation of matter and motion, which he enunciated in the 1740s contains the dialectical idea that the infinite variety of natural phenomena has a common factor in the form of the law of the conservation of matter, which combines them into a single whole. This general law also discloses the unity of matter and motion. On the basis of his law Lomonosov advanced the idea that motion could not exist without matter. Examining the origin of heat, he reached the conclusion that since motion could not take place without matter it followed that heat was produced by the motion of matter.

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* F. Engels, *Anti-Dühring*, Moscow, 1962, p. 37.

Subsequently he elaborated a system of dialectical ideas, which was relatively lucid for the time, concerning the variability of nature, from heavenly bodies to the living organisms inhabiting our planet. He sought to design a general theory of "changes, from the smallest and almost imperceptible ones that occur on Earth, to the greatest, which result in the endless process of the destruction and the formation of worlds".* This system founded on the sum total of the knowledge that had been accumulated by the mid-18th century and the knowledge which Lomonosov himself had acquired, may well be regarded as an important factor in the development of dialectics. It was this aspect of his generalisations which particularly attracted the attention of the foremost 19th-century Russian thinkers and men of arts. Odoyevsky, for instance, wrote that we should bend our knee before Lomonosov, "that gifted representative of versatile Slav thought" who "deep within him discovered the mysterious method of studying nature not in its individual aspects but by taking all its parts together and harmoniously absorbing all the diverse knowledge obtained thereby".**

In his essay *On the Strata of the Earth* Lomonosov makes a brilliant effort to describe all nature as an objective reality existing in a state of constant change. Before turning to individual problems of geology and other sciences, he defines some of their common basic principles. "Commencing this work," he wrote, "it is necessary to establish sound foundations and rules and to adhere to them undeviatingly."*** This invariable general principle, in his opinion, should be recognition of the fact that heavenly bodies, our planet, its surface, etc., are in a state of constant change. "...It should always be borne in mind," he wrote, "that when the physical bodies on Earth and in the whole world originated they were in a different state from that in which we see them now: they have undergone great changes, which is borne out by history and by comparing ancient and modern geography, and also by the changes in the Earth's surface that occur in our time. If the chief and greatest bodies of the universe such as planets and even immobile stars change, are lost in the heavens and then appear again, then how can the tiniest particles of our small globe, i.e., mountains (which seem so enormous to us) be free from change? Many people vainly think that everything we see was made by the Creator, that mountains, meadows and waters and even the different minerals appeared together with the whole world, and that, therefore, there is no need to investigate the reasons why minerals are found in different places and have different inner properties. Such reasoning is extremely harmful to the development of all the sciences and, consequently, to the acquisition of a knowledge of the terrestrial globe, especially to the science of mining, although such clever people may easily become philosophers when they have learned by heart the words 'God made it so', and use them to explain everything."*

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* M. V. Lomonosov, *Complete Works*, Vol. 3, p. 484.

** V. Odoyevsky, *Complete Works* (Russ. Ed.), Part I, St. Petersburg, 1844, p. 389.

*** M. V. Lomonosov, *Complete Works*, Vol. 5, p. 574.

He was absolutely confident that great changes had taken place in the universe, that heavenly bodies, from the biggest stars to the planets, appear, change and then disappear, and that our planet was also in a constant state of change. This was a bold challenge not only to theology and scholastic philosophy, but also to metaphysical thought.

The above dialectical generalisations cannot be considered a scientifically well-argumented, lucid theory of the dialectical development of the material world, because Lomonosov was not aware of the fundamental laws of the dialectical development of nature. It has to be emphasised, moreover, that he was not content with merely formulating this general principle, but used it as a basis for solving many problems in various branches of knowledge.

Developing the ideas of Giordano Bruno and other scientists of previous centuries, who had held that the universe was infinite and that there was no end to the number of stars, Lomonosov sought to substantiate his own concept of the endless state of change of the heavenly bodies, their appearance and destruction. He made a thorough study of the processes taking place in outer space. He examined light phenomena and drew the conclusion that the nature of light was in general the same on the Earth, the Sun and on other luminaries, and was subject to one and the same laws. Enlarging on this idea, he deduced that "in all systems of the universe there are identical first-beginnings and elements because the rays coincide in every way. The white-hot Sun and the white-hot bodies on the Earth consist of the same substance".* Proceeding from these general principles Lomonosov sought to prove that the changes which heavenly bodies underwent, from their appearance to their disappearance, had common causes and the same objective laws.

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* Ibid., pp. 574-75.

He believed that there were constant violent changes on the Sun's surface and hoped for the time when the human eye might "behold more closely" what was taking place there. More than a 100 years later, as a result of scientific and technical progress, man was already making fairly detailed observations and studies of solar processes. Observations of the Sun conducted by modern astrophysicists with the help of photography, photometry, spectral analysis and other means have fully corroborated the picture which Lomonosov unfolded in general outline as far back as the middle of the 18th century.

Lomonosov's discovery of an atmosphere on Venus not only proved the correctness of the Copernican system but also sustained the idea about changes taking place on heavenly bodies. In 1761, while observing Venus as it was passing in front of the Sun's disc, he noticed certain phenomena which provided sufficient grounds to assert that Venus had a gaseous envelope. This made him conclude that there was air on Venus similar to the Earth's atmosphere.

He was fully convinced that, were it not for the Earth's atmosphere, people would have had a better knowledge of the heavenly bodies and the changes which take place on them. Drawing up the plan of his essay *Investigating*

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* Ibid., Vol. 3, p. 245.

the Origin of the Northern Lights and Other Similar Phenomena, he wrote: "If the Earth had no atmosphere, we should be able to see the changes taking place in the Milky Way and observe the constant process of the birth of new worlds."[*] It has taken much longer to confirm this assertion than it did to provide proof of his concept of the Sun.

He applied the theory of changes of heavenly bodies also in examining the evolution of our planet.

Engels wrote: "Geology arose and pointed out not only terrestrial strata formed one after another and deposited one upon another, but also the shells and skeletons of extinct animals and the trunks, leaves, and fruits of no longer existing plants contained in these strata. The decision had to be taken to acknowledge that not only the Earth as a whole but also its present surface and the plants and animals living on it possessed a history in time. At first the acknowledgement occurred reluctantly enough. Cuvier's theory of the revolutions of the Earth was revolutionary in phrase and reactionary in substance. In place of a *single* divine creation, he put a whole series of repeated acts of creation, making the miracle an essential natural agent. Lyell first brought sense into geology by substituting for the sudden revolutions due to the moods of the Creator, the gradual effects of the slow transformation of the Earth."[**]

In this branch of knowledge Lomonosov anticipated what Lyell was to elaborate in greater detail in the first half of the 19th century. Lomonosov believed that the Earth had over a long period of time passed through many stages of development and undergone radical changes. He was the first among the thinkers and natural scientists to advance the hypothesis that our planet had once been a molten mass of matter, which had gradually cooled and hardened, and that rocks had originated at a certain stage in these complex transformations. Rocks were now quite different from what they had been during the initial period of their formation. To uphold this conclusion he formulated a general hypothesis on the evolution of our planet.

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[*] Ibid., p. 384.

[**] F. Engels, *Dialectics of Nature*, Moscow, 1966, pp. 27-28.

"All this is borne out by the following," he wrote. "The Earth was once a fluid substance, as may be seen from its round shape. Then, when this substance began to solidify into different strata and each stratum began to settle down according to its weight, metals obviously settled much closer to the Earth's centre than where they are now found, not infrequently on the surface of the Earth itself. Thus, there can be no doubt that metals originated after the Earth had come into being, when it had already hardened, and land and other essential factors for the formation of deposits had appeared."* By advancing these concepts he was laying the first foundations of geology.

Lomonosov analysed the processes occurring in the depths of the Earth and on its surface and set forth a series of interesting dialectical ideas.

His works *On the Earthquake Origin of Metals* and *On the Strata of the Earth* contain a relatively complete, detailed and well-sustained picture of the changes that had taken place, or were taking place on the surface of the Earth and in its depths. He skilfully combined the elaboration of general ideas about the development of nature with concrete analysis of separate natural phenomena. *On the Strata of the Earth* is typical of this approach.

Lomonosov rose above the limited metaphysical positions of his predecessors and contemporaries, and refused to regard the transformations on the surface of the Earth and in its depths in isolation from the changes on other heavenly bodies. He believed that there was a relationship between the changes in the angle of the Earth's axis, magnetic storms, tides and ebbs on large expanses of water and other natural phenomena.

In his opinion the incessant transformations of the Earth's surface were due to two categories of causative factors, internal, primarily physical factors, and external—chemical processes. The external factors, he said, were the action of wind, rain, river currents, sea tides and ebbs, ice, forest fires, the action of the heat and cold causing changes in the structure of rocks, and so forth.

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* M. V. Lomonosov, *Complete Works*, Vol. 5, p. 612.

By analysing the effects of all these external factors he was able more fully and thoroughly than many of his contemporaries to explain the transformations taking place on the Earth's surface, and in so doing helped to shake the metaphysical concepts of the Earth.

His definition of the role of internal factors, also instrumental in causing changes on the Earth's surface, was likewise new. He considered that external factors alone could not account for all the changes taking place on the Earth. The formation of mountains and lowlands, for example, was not only the result of the action of heat, wind, tides and ebbs, and so forth; one should search for the causes of these phenomena in the depths of the Earth. He made a thorough study of earthquakes and concluded that they were the principal cause of the formation of mountains. "...The whole surface of the Earth bears proof of this," he wrote. "Wherever there are crevices in the mountains there are signs of Earth's tremors, these having been stronger where there are greater piles of rocks and deeper declivities and chasms.

"It seems to me that a person investigating the causes of all this would be on the right track if he were to search for them in the depths of the Earth and disregard the views of ancient Babylonians, who attributed them to the action of the planets."*

No less brilliant were his conjectures about the origin of minerals and metals, climatic changes, development of living organisms and so forth.

He was absolutely sure that minerals were natural substances, and that in order to understand the essential difference between them it was necessary to study their natural history. "The question," he wrote, "of whether rocks are being born all the time or whether they all appeared at one and the same time has been solved long ago by the rise of new natural formations, which, of course, did not appear in accordance with the popular belief that rocks allegedly grow in fields and along shores like some earthly fruit."**

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* Ibid., p. 304.

** Ibid., p. 594.

He acknowledged that minerals owe their appearance to different causes, specifying the following as the principal ones: "...(1) solidification of clay, (2) impregnation of sticky fluid matter, (3) accumulation and sedimentation, (4) condensation, and (5) granulation." "I do not deny the existence of other causes," he wrote, "but undoubtedly these are the main ones, which may include others. Moreover, they adequately prove that rocks are not primordial matter, but are derived from clay ... at the same time neither is clay primordial because there is an almost infinite variety of rocks."*

Naive and limited as these views were, they, nevertheless, anticipated the discoveries that were made many years later. According to modern mineralogy most minerals are formed as a result of simple sedimentation in the process of increasing concentration of solution. Lomonosov also mentioned this, when he wrote that rocks might be formed out of particles of mineral substances settling to the bottom of a liquid.

As we have said already, Lomonosov played an important role in investigating the process of mountain formation. On the basis of an analysis of all the accumulated geological information and his personal observations during his travels at home and abroad he concluded that mountains arose as a result of the lowering of the upper layers of the Earth into cavities that were formed in it, or because of volcanic activity. Orogenesis was not a smooth-flowing process. Besides the violent volcanic upheavals which frequently caused the formation of mountains, there was the relatively slow process of the subsidence of the upper layers of the Earth. He wrote: "1) Frequently what we see on the surface once lay in the depths of the Earth; consequently there is much in the Earth that once lay on its surface ... 2) broken, craggy mountains and scattered rocks are signs of great earthquakes that were accompanied by flames or smoke spouting from the bowels of the Earth, 3) such phenomena have occurred many times in the past, they are taking place at present, and they will hardly ever cease, 4) the greater the mountain the older it is as a rule; the biggest ranges were formed before all the others, because at first there was incomparably more combustible matter in the Earth, the amount of which has certainly diminished over many thousands of years, much of it being scattered over the Earth's surface ... 5) the older the world becomes the less frequent will such great changes occur, particularly the formation of mountains as a result of earthquakes. . . ."*

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* Ibid., p. 600.

Lomonosov's concept of the different ways of the natural formation of mountains may be regarded as a magnificent attempt to solve this problem scientifically. His conjecture anticipated such subsequent achievements of geology as the theory that mountain building is the result of volcanic activity and the subsidence of adjoining tracts of land. True enough, he took only the first step towards furnishing a scientific solution to the complicated and contradictory process of mountain formation and its general laws, for 18th-century geology was incapable of providing an all-round explanation of this problem. What may be emphasised, however, is that Lomonosov took into account all the knowledge that had been accumulated by the mid-18th century and had advanced the dialectical idea of development even when examining such a complicated geological process as orogenesis.

His ideas concerning the formation of peat, coal and oil are profoundly original. He was one of the first to substantiate the idea that these minerals have a common origin, namely, living organisms that had once inhabited the Earth and which due to certain causes had been deposited in geological strata where they were transformed into peat, coal, oil, etc., as a result of various physical and chemical processes. "Coal," he wrote, "might be justifiably called a synthetic combustible mineral, for there is sufficient proof showing that it is a product of vegetable matter, especially forests, which, in the period of great upheavals were buried in the ground, where they fell into decay as a result of subterranean heat and then became petrified after being impregnated with the Earth's juices over a very long period of time, because 1) their position in the ground is horizontal like that of other petrified animals, or parts of vegetable matter, 2) coal seams are frequently divided by the petrified remains of animals that once inhabited the Earth, 3) among the coal we frequently find petrified tree trunks half turned into coal and bearing signs that they had been chopped down with an axe, and 4) do not in the least differ from coal in appearance, colour, or layers."* Thus, on the basis of the presence of remains of vegetable and animal life and the results of chemical analysis Lomonosov substantiated his views regarding the origin of coal.

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* Ibid., p. 587.

His idea concerning the natural process of formation of petroleum is likewise of great scientific interest. In this case Lomonosov relied mainly on chemical investigations and sought to prove that petroleum was also of organic origin, and that it was formed in the depths of the Earth as a result of destructive distillation of vegetable remains. This conjecture was verified more than a century later by the great Russian chemist D. Mendeleyev, who thoroughly analysed the problem and reached the conclusion that one of the sources of petroleum was the mass of organic substance which had undergone radical changes in the Earth's layers.

Lomonosov's views on the natural origin of amber were very close to the present-day scientific concept. The majority of prominent 18th-century scientists maintained that amber was of purely mineral origin. Lomonosov opposed this view and believed that amber was the fossilised resin of trees. One of the arguments which he advanced in support of this theory was the fact that remains of insects were sometimes found in amber. Defending this argument he wrote: "Let those who reject such lucid proof listen to what the worms and insects locked in amber have to say: Enjoying the warm, sunlit summer we wandered over luxurious humid vegetation gathering our food; we delighted in the wonderful weather, followed alluring scents to their sources, and crawled and flitted over grasses, leaves and trees unafraid of any danger. Then we alighted on the sticky liquid resin exuded by the trees, which transfixed us and, continuing to pour, covered us from all sides. Then there was an earthquake and our forest sank into the ground and was covered by the sea; the trees toppled over and together with the resin and ourselves were immersed into silt and sand; ages passed and the mineral juices impregnated the resin and made it very hard. In a word, it became amber. Thus. our tombs became more splendid than those of the noblest and richest people.... We became part of the ore deposit at the same time and in no other manner than the petrified or rotted trees that are found in it."*

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* Ibid., pp. 384-85.

Lomonosov's assertion concerning the variability of the climate and the related transformation of living organisms inhabiting the Earth likewise merits serious attention. He attributed the presence of animal skeletons and the remains of tropical plants in the strata of the Earth adjoining the Arctic Ocean to the climatic changes occasioned by the swing of the Earth's axis. "Natural scientists are divided on this issue," he wrote. "Some maintain that these remains have been transferred from one place to another as a result of some extraordinary violent internal subterranean action caused by the great transformations that once took place on the Earth. Others attribute their presence in the North to the imperceptible change in the inclination of the terrestrial globe which has been going on for many centuries and altering the distance from the ecliptic to the pole."**

Lomonosov sided with the latter view. His opponents asserted that under certain circumstances elephants could have migrated from the tropics to the cold northern regions and that it would have taken them a relatively short time to do so. Sweeping aside these arguments, Lomonosov replied: "Suppose the elephants, being great animals and capable of travelling long distances, did migrate to our parts ... but then what about the testudinal marine reptiles which cannot migrate but whose fossils, nevertheless, are found on dry land in the northern mountains. Yet the seas that lie close to these places do not contain these creatures: they live in great numbers in the seas of the torrid zones."*

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* Ibid., pp. 610-11.

** Ibid., p. 616.

After analysing analogous facts and observations, he arrived at the conclusion that climatic and consequently, environmental changes resulted in changes of living organisms. "It follows, therefore," he wrote, "that in ancient times the North had a very hot climate in which tropical animals, including elephants and tropical plants, could live and proliferate. Hence, there is nothing unnatural in the fact that their remains are found there."**

Although expressed in general terms, Lomonosov's evolutionary concepts that plants and animals developed under the influence of climatic changes and other factors dealt a serious blow to metaphysics at a time when metaphysical views on questions of vegetable and animal organisms held undivided sway, and when biology was still undeveloped. It was not surprising, therefore, that the proponents of the old views on the living world vehemently opposed this standpoint and, by juggling with facts, endeavoured to disprove it. For instance, Academician G. Krafft of the St. Petersburg Academy in his physics lectures clung firmly to the idea of the absolute invariability of the species.

Hypothetically Lomonosov considered it possible that suitable conditions for the appearance of living organisms, including man, existed on other heavenly bodies. He believed for instance, that since Venus had an atmosphere there could also be living organisms there, including human beings. Hence, too, we observe his persistent desire to step beyond the narrow limits of metaphysical conceptions and to observe nature in the process of its everlasting development.

He considered that all changes on the Earth, in its depths and in the organisms of its inhabitants take place over long historical periods, and rejected the Biblical legends that the Earth was only a few thousand years old. By comparing geological processes and drawing on the achievements of all the past generations of scientists he came close to determining the actual time when these geological processes took place. For instance, he believed that the change in the inclination of the Earth's axis was an extremely slow process lasting hundreds of thousands of years. "Herodotus," he wrote, "quoted Egyptian philosophers to the effect that the ecliptic was once at right angles to the equator. Since then it has changed its position and now lies about $66^1/_2°$ away from the pole. This process, according to ancient and present-day observations must have lasted 399,000 years."*

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* Ibid., Vol. 5, p. 615.

** Ibid., p. 616.

According to Lomonosov, the processes of the formation of minerals, metals, coal, oil, amber, etc., were equally prolonged. This is what he says about the changes in the shape of diamonds in natural conditions: "Being the product of crystallisation diamonds must be originally as angular as they are translucent, for we frequently find diamonds with angular surfaces such as those used by glaziers.... At the same time there are diamonds whose surface has been worn to smoothness. We know that diamond-cutting is a very difficult task requiring extremely hard materials and rapid mechanical motion and, therefore, we can imagine the length of time it takes a diamond rolling about in the sand to wear away the sharp corners of its surface. But we cannot deny the fact that diamonds at times lay for centuries without moving and could not lose their original angularity."**

At the same time Lomonosov was well aware that it was extremely difficult to determine even approximately the periods when geological transformations had taken place: "...I admit," he wrote with regret, "that I do not know how to correctly establish the time of their occurrence nor are there any signs to help me...."***

The analysis of Lomonosov's ideas on the birth and disappearance of heavenly bodies, on the changes inside our planet and on its surface which take place in space and in time, offers sufficient grounds to conclude that he was elaborating a system of dialectical ideas about the evolution of nature, a system which was relatively consistent for his time. He rendered a service to science, primarily because he was one of the first to advance evolutionary ideas, and secondly, because many of them were verified in the process of the development of scientific thinking and became part of human knowledge.

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* Ibid., p. 616.

** Ibid., p. 628.

*** Ibid., p. 618.

Lomonosov wanted to rise above the narrow-minded metaphysical system of examining objects and phenomena in complete isolation from one another. He advanced and systematically developed the dialectical idea of the interaction and interconditionality of objects and natural processes. The justifiability of this idea was sustained first and foremost by the universal character of the law of the conservation of matter and motion and, secondly, by the presence of certain common properties in the infinite variety of natural substances and phenomena. Developing this dialectical idea, he concluded that there is a relationship and a concordance of all causes, and called this concordance an immutable and constant law of nature.

He was not satisfied with formulating a general and somewhat abstract definition of the essence of this relationship, but sought to show the concrete forms in which it was manifested in nature, in society and in the development of sciences.

This idea is dealt with in greatest detail in his works on physics, chemistry and geology. As a scientist of the encyclopedist type, fruitfully working in almost all branches of knowledge, he was in a position to examine natural processes from all angles and trace their ties and interaction.

For the first time in the history of science he carried out a series of experiments disclosing some important links between physical and chemical processes. Rejecting the metaphysical idea that physical and chemical phenomena are absolutely unrelated processes, he convincingly proved that they were indissolubly linked with one another, and furthermore, that they were different aspects of the same substances. "After examining compound substances by means of chemical experiments," he wrote, "chemists, as a rule, do not look for other ways to discover their secrets, although physics armed with the laws of mathematics tells us that there are many of them."*

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* Ibid., Vol. 2, p. 573.

Lomonosov pointed out that many chemists were investigating the properties of bodies in a one-sided manner, and considered it imperative to take into account the indisputable fact that all natural properties are closely interrelated and in constant interaction with one another. He asserted that reason cannot "pass over properties without investigating them, when a clear knowledge of things is required; for it is senseless to search for the causes of things while possessing inadequate knowledge of the things themselves. Therefore it is necessary to understand the specific properties of every compound substance subjected to chemical analysis and to determine and define them as correctly as possible, so that when their components become known as a result of experiments, to be able to observe how, to what extent and in what way a given property may change depending on the change of a known component, and on the basis of mutual conformity to determine the nature and the true causes of the latter."*

His understanding of heat and other physical phenomena did not, generally speaking, go beyond the limits of mechanical materialism. Yet, perceiving the mutual relationship between the speed of the rotational motion of particles and rising temperature, or between a colder and a warmer body, he viewed these processes in their indissoluble unity and interdependence. If a warmer body, he explained, is in direct contact with a cooler one, the particles of the former, whose rotational motion is faster, act on the particles of the latter, accelerating their rotation by communicating part of their motion to them. This interconnection takes place in conformity with the law of the conservation of matter and motion.

Of great scientific interest are Lomonosov's thoughts about the interconnection of inorganic and organic substances. His solution of this problem is based on the fact that both types of substances have common properties and common general laws. Considering that all substances con sist of infinitely small and constantly moving particles, the difference between them can be traced to the way these particles are united and the arrangements into which they fall.

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* Ibid., pp. 573-75.

"All bodies," Lomonosov wrote, "are either organic or inorganic. The parts forming organic bodies are arranged and united in such a way that the cause of one part is contained in another with which it is united. The particles of inorganic bodies have no other causal relationship than mutual cohesion and arrangement. Organic bodies are primarily natural bodies, namely, of the animal and vegetable kingdoms. Structurally their tissues, veins, globules and the juices circulating in them are dependent on one another. Inorganic bodies, which are always compounds, form the mineral kingdom—an extensive field of chemical matter."* The contemporary lack of knowledge of biological processes prevented him from making a thorough analysis of the interconnection between mechanical and chemical processes, on the one hand, and biological processes occurring in living organisms, on the other. Consequently, he attributed the complicated process of the origin of sense perceptions and ideas primarily to the interaction of mechanical, physical and chemical phenomena in the human organism, and thus inevitably offered an oversimplified, mechanistic interpretation of the involved interdependence between inanimate and animate nature. But even such an approach played a progressive role at the time and paved the way for the appearance of a more profound, dialectical view on the interdependence between inorganic and organic nature.

As mentioned above, Lomonosov also spoke about the cause-effect relationship between inorganic nature and the living world (influence of climatic changes on the development of vegetable and animal organisms), thus stating, although in very general form, the important principle of biology that living organisms interact with the surrounding world. The constantly changing climate modified vegetable and animal organisms. In ancient times the cold northern regions had possessed a warm tropical climate and were inhabited by living organisms native to hot countries. As it gradually became colder these organisms began to adapt themselves to the new climatic conditions. His generally formulated dialectical principle of interconnection between organisms and their environment was not scientifically elaborated until more than a century after his death.

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* Ibid., p. 553.

Lomonosov sought to trace the interconnection that exists between various social processes.

At the time it was widely thought that the cold North had far fewer useful minerals than there were in places with a hot climate. He rejected this notion as erroneous and harmful from the practical point of view, and offset it with his own hypothesis that metals and minerals originated in the process of the evolution of our planet. While on the subject he also mentioned the interconnections existing between the level of prospecting and utilisation of natural resources, on the one hand, and the size of the population, on the other. The northern regions have many useful minerals, he wrote, but there was "no one to search for these treasures because of lack of knowledge, and the more so because these regions are sparsely populated".* He arrived at the conclusion that the faster the population of Russia expanded, the more deposits of useful minerals would be prospected and industrially exploited in the North. In particular, it was this idea that prompted him to press for a number of social reforms that would speed the growth of the population.

He mentioned other interconnections between social phenomena, and arrived at an almost correct understanding of the relationship between material production and scientific achievements. These mutual relations, he believed, were expressed primarily in the fact that production determined the rise and development of sciences, while the latter "opened the road" to production; therefore, "both concordantly serve a common cause."**

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* Ibid., Vol. 5, p. 621.

** Ibid., Vol. 2, p. 351.

Lomonosov's thoughts that there exist direct and indirect ties between bodies and phenomena, are of definite interest. In his opinion corpuscles, or molecules, cohere indirectly when they are joined to each other by means of alien particles, and come into direct contact when there are no alien particles between them.

On the basis of his belief that there is no such thing as an absolute vacuum and that everywhere there exists a material medium, he concludes that heavenly bodies, for instance, including the Sun and the Earth are mutually connected but not according to the principle of action at a distance, but by means of the material medium that lies between them.

Dwelling on the interconnection of various causes of one or another phenomenon, he divides these causes into principal and secondary, or immediate and remote. "There is only one immediate cause of every phenomenon," he writes, "but there can be many remote causes, some of them even of an opposite nature. For instance, the immediate cause of rain is the predominance of the weight of water particles over the force of their cohesion with air particles keeping them suspended in the atmosphere. The remote causes may be heat or cold: heat, because the rarefied air comes into contact with a smaller number of points on the surface of water particles and does not adhere to them strongly enough; cold, because owing to the compression of the air, water particles come into mutual contact with each other and merge into drops. As this happens their volume increases threefold while their surface expands twofold, but their volume grows in conformity with the force of gravity, while the surface expands in conformity with cohesion. Hence, as a result of the preponderance of the force of gravity over the cohesive force drops tend to fall to the Earth."* The above discourse epitomises Lomonosov's versatile approach to the study of nature. Overcoming the metaphysical division of various branches of knowledge, he convincingly showed the organic relationship and unity of all natural sciences.

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* Ibid., Vol. 3, pp. 291-93.

Best of all he explained the relationship between chemistry and physics. Maintaining that natural bodies possess chemical, physical and other properties, all of which exist as a single undivisible whole, he formed the opinion that these properties could not be studied separately but only with the help of all sciences. Furthermore, he created a special science called physical chemistry, which joined together two great branches of knowledge. The purpose of the new science was to study the processes taking place in compound chemical substances and phenomena on the basis of the principles and laws of physics and chemistry.

He called for close co-operation between chemists, physicists and mathematicians saying that "it is legitimate to call chemistry the hands of physics, and mathematics its eyes", and that "in examining the internal properties of bodies both sciences greatly assist one another".[*] Elsewhere he wrote: "Undoubtedly sciences promote each other in great measure, as for example physics assists chemistry, mathematics physics, and jurisprudence and history prosody."[**]

He extended his dialectical idea about the interconnection of sciences to medicine and biology, too. Medicine, he said, cannot solve many of its problems independently of other sciences. It can achieve positive results only in close contact with chemistry, biology and physics. "Through a knowledge of the properties of human bodies," he wrote, "medicine ascertains the causes of ill-health and frequently saves sick people from the grave by applying the necessary measures. Most diseases occur through damage to the vital fluid matter circulating in our bodies, whose properties and components, as well as the causes engendering detrimental changes and those that cut short these changes, cannot be ascertained without the application of chemistry. Chemistry gives us knowledge of the natural mixing of blood and nutritious juices, the structure of good or bad foods; with its help we can prepare medicines not only from grasses but also from minerals. In a word, a physician is not a physician if he is not skilled in chemistry...."*

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[*] Ibid., Vol. 2, p. 354.

[**] Ibid., Vol. 5, p. 618.

At the same time he considered that not all interconnections between sciences stimulated the development of knowledge. Far-fetched, artificial combination of sciences was useless. He wrote: "Of what use are good verses in proving the Pythagorean theorem? Or how can a knowledge of the causes of the rise and fall of the Roman Empire serve to explain the circulation of blood in an animal organism? Similarly the Nomocanon gives nothing to students of astronomy."**

Thus, it is clear that in questions of unity and interconnection both of the objects and phenomena of the material world, and of the different branches of knowledge, Lomonosov showed himself capable of profound philosophical generalisations.

He came close to a correct understanding of how substances and processes are transformed into qualitatively different ones, and to some extent even opposite substances and processes. He pointed out that plants, their growth and development have specific qualitative peculiarities; but when these plants are hurled into the depths of the Earth as a result of earthquakes or other geological processes, they first undergo qualitative changes and turn into coal, petroleum or amber, and secondly they are subjected to the actions of many other general laws.

Analysing the transformation of plants into peat and then into coal, Lomonosov writes: "...we can easily picture what happens to peat. First, excessive humidity as a result of initial heating passes through the thin crust, thus preparing peat for its transformation into coal. After that the matter which is compressed by the weight of the crust grows hotter and begins to burn. But since combustion takes place without the access of free air, and consequently without flames, peat turns into coal."*** In its turn coal is transformed into petroleum or pitch, likewise as a result of certain processes taking place inside the Earth.

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* Ibid., Vol. 2, p. 357.

** Ibid., Vol. 5, p. 618.

*** Ibid., p. 608.

Lomonosov also mentions the reverse process, when matter that is ejected to the surface from the depths of the Earth during earthquakes or volcanic eruptions, undergoes qualitative changes and begins to interact with totally different processes.

It should be pointed out in this connection that he assumed that it was possible artificially to change one element into another. Criticising alchemistry, Lomonosov, however, did not deny its rational aspects. Many experiments performed by alchemists were of scientific and practical value and played an important role in the development of chemistry. Lomonosov himself did not reject the idea of the possibility of changing some metals into others. "Chemical experiments," he wrote, "which are conducted with the idea of making metals, or transmuting baser metals into rare ones, are for the most part misguided or doubtful. Nevertheless, there is no doubt that many of them are trustworthy, and even if they have failed to bring to life alchemists' dreams of great riches, they do confirm the possibility of making new metals, or transmuting others."*

His works contain conjectures concerning the dialectical contradictoriness of certain phenomena as, for example, his ideas about the transformation of external, that is, surface phenomena into internal, and vice versa. The above excerpts from his works on geology carry proof of this.

He entertained some interesting thoughts about such contradictions as the usefulness and harmfulness of one or another natural object or phenomena. He considered that "there is nothing however harmful or dangerous in the world which at the same time is not useful or beneficial", or that "when talking of unpleasant things we derive all the greater pleasure in partaking of those that are pleasant".**

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* Ibid., pp. 612-13.

** Ibid., p. 296.

Lomonosov disclosed the specific contradictory effects caused by wind, frost, mountain formation, etc. Winds sweeping over water expanses, he wrote, not only breed storms which are often harmful to man, but also impart motion to sailing ships. No less contradictory are the effects of atmospheric electricity, earthquakes and other natural phenomena.

"Earthquakes," he wrote, "are disastrous and we have had occasion to grieve over the destruction of whole nations that had perished as a result of Earth's tremors, demolishing towns and devastating the land. But they also benefit and multiply the well-being of the people by producing very important metals and other useful things."*

He made some laudable attempts to overcome the metaphysical view regarding human knowledge and the development of science and culture. In those days many historians of science and culture considered the process of accumulation of knowledge as nothing more than an increase in the number of facts and observations unaccompanied by any radical change in the view of nature, or by new theories penetrating deeper into the nature of things, etc. Deep-rooted was the metaphysical opinion that scientific discoveries were not logical links in the general process of development of knowledge, but accidental events in the work of one or another scientist. Lomonosov opposed such conceptions regarding the development of various branches of knowledge and culture as a single, complicated and constant process. He held that there were two aspects to the development of knowledge. First, knowledge was constantly increasing in volume and ever more natural objects and phenomena were being studied. Second, knowledge was being constantly perfected, and obsolete concepts, hypotheses and premises were being replaced by new scientific conclusions and theories providing a more correct explanation of reality. It was in this way that he visualised the replacement of the Ptolemaic system with the more perfect and scientifically sustained system of Copernicus.

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* Ibid., p. 298.

Lomonosov sought to encompass the entire history of the development of science and to select the most important links in the progress of scientific knowledge displaying this tendency with particular clarity in his philosophical works.

In just the same way Lomonosov assessed the work of the scientists after Aristotle. Although he had much praise for the experiments conducted by the great 17th-century English scientist Robert Boyle, Lomonosov rejected everything that was obsolete and erroneous in his works. Boyle had reached the conclusion that metals increase in weight after annealing in a sealed vessel. Lomonosov weighed the metals before and after annealing without unsealing the vessel and discovered that their weight was the same and thus proved that Boyle had erred in his experiments. The Englishman weighed the metal in a sealed vessel before annealing and weighed it again after annealing but with the vessel unsealed. Yet it is known that as much air rushes into a vessel in which the annealing was done as was combined with the metal during the annealing.

Lomonosov opposed obsolete views held by many scientists, including Isaac Newton.

Lomonosov was firmly convinced that as long as man inhabited the Earth the process of improvement and extension of his knowledge of nature would never cease and not a single branch of knowledge would ever attain such perfection that it could not be enriched with new data or conclusions. He held that what today appeared to be perfect and ascertained to the last detail, tomorrow would not fully satisfy mankind's requirements, and that meant that old theories must be verified and new ones elaborated, that yesterday's hypotheses would today become scientific truths, etc.

Assiduously and comprehensively he traced the historical connection between different stages of the single process of development of knowledge and considered that each stage in the history of science was necessary and based on laws, and that it created the prerequisites for further progress.

He praised the development of knowledge about the origin of light and colours, and the achievements in mechanics, chemistry, astronomy, geology and mathematics. In his opinion the wealth of information accumulated by alchemists should be used to further chemistry. Alchemistry, as we know, was an essential stage in the rise of chemistry; it was the initial form of that branch of knowledge, which subsequently developed into a real science thanks to the investigations and theoretical generalisations of Boyle, Lomonosov, Lavoisier and other scientists.

Lomonosov regarded the process of the development of knowledge about heavenly bodies and the universe also from concrete historical positions. He held that Copernicus, Galileo, Kepler, Newton and other great men would have had no discoveries to their credit and would not have advanced in knowledge had they not taken the works of the preceding generations of scientists into account.

Lomonosov's *On the Layers of the Earth*, *On the Earthquake Origin of Metals*, *Elements of Metallurgy and Mining* and other works, contain an analysis of the development of the knowledge of geological processes over a long period of time. To sustain his conclusions that the surface of our planet is constantly changing, he frequently quoted from Pliny and other ancient scientists. "...Let us hear," he wrote, "what Pliny, among other authors, briefly says about these changes:

" 'Lands,' he says, 'are born and suddenly rise from the sea. It is as though nature returns to another place what its waters have swallowed elsewhere. Such are the islands of Delos and Rhodos which, as is known, rose from the sea.' "* Lomonosov rejected the views of the ancient Babylonian scientists who attributed the appearance of mountains to the influence of other planets, and allied himself with scientists who considered subterranean fire to be the cause of earthquakes.

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* M. V. Lomonosov, *Complete Works*, Vol. 5, p. 300.

Particular attention should be attached to Lomonosov's dialectical idea that the development of knowledge is a contradictory process, that different scientific concepts, theories, and views will always clash with each other. Such clashes were a factor stimulating scientific progress. Without them scientists would have lacked the incentive to conduct new experiments and so forth.

Lomonosov's efforts to break through the narrow limits of the metaphysical world outlook, to enrich natural sciences and philosophy with dialectical ideas are one of the distinguishing features of his philosophy.

Chapter VII

LOMONOSOV'S ETHICAL VIEWS

Ethical questions occupy a prominent place in the vast legacy of ideas that has come down to us from Lomonosov. His voice rang out boldly and proudly in defence of advanced ethical principles in the monarchist-landowner Russia of the 'forties and 'sixties of the 18th century, when the country was ruled by the reactionary secular and religious feudal lords, when the prevailing moral principles justified obscurantism, brutal treatment of the working people and persecution of all those who worked for Russia's economic and cultural independence, for her prosperity and the advance of education, science and culture.

Lomonosov was still alive when a sharp struggle flared up around his ethical ideals and principles. The court and the higher clergy were apprehensive of his patriotic sentiments and of his deep love for the Russian people whose honour and dignity he defended against all slanderers and denigrators. This was one of the principal reasons why the reactionary ruling circles saw to it that he was placed in difficult and humiliating conditions. The court camarilla and the foreigners occupying lucrative posts in many institutions of the capital, including the Academy of Sciences, sneered and made much ado about his "muzhik" background and incited all kinds of persecutors of Russian science and careerists against him. Lomonosov, who returned from abroad towering head and shoulders above other members of the St. Petersburg Academy, had to struggle for four years to obtain a post at his native Academy.

In an application requesting a post at the Academy forwarded to Empress Elizabeth in January 1742, he wrote that during his studies in Germany he had "mastered physics, chemistry and mining to such a degree" that he was "now qualified to teach and to write useful books with new ideas on these subjects".* But his repeated requests to the Academy were in vain. At long last he was given the post of assistant professor, although he was fully qualified to become a professor and a member of the Academy. The government reluctantly appointed him professor of chemistry and member of the Academy only after Leonhard Euler, a scientist who was widely known in the West and who had a high opinion of Lomonosov's works, had intervened on his behalf. This appointment, however, did not remove the difficulties and obstacles which were put in Lomonosov's way by the ruling circles of the reactionary nobility.

No sooner had Lomonosov taken up his post than Johann Schumacher and his followers began intriguing to make Lomonosov's working conditions intolerable, to oust him from the Academy and to install a mediocre foreign scientist in his place. With this aim in view Schumacher decided to send Lomonosov's theses, that had already been approved at a general meeting of the Academy, to Professor Leonhard Euler in Berlin hoping that there he would find fault with them. At the same time Doctor Abraham Boerhaave the Younger, recently arrived from the Netherlands, was informed that in addition to the work he was engaged in he would be appointed professor of chemistry with a rise in salary.

I. Shuvalov, M. Vorontsov and other courtiers exposed Lomonosov to all sorts of privations and humiliation. Following one of Shuvalov's "pranks", Lomonosov sent him an indignant letter saying: "No one has ever wronged me as deeply as Your Excellency. You summoned me today. I thought that perhaps you had some encouragement to offer me in my just demands." But apparently Shuvalov intended to make a fool of Lomonosov by setting him at odds with the writer A. Sumarokov. To this Lomonosov vehemently replied: "You shall not find me playing the fool at the table of the nobility or the landowners, or even before God himself."*

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* M. V. Lomonosov, *Complete Works*, Vol. 10, p. 326.

Lomonosov's defence of progressive ethical principles and their application in science and culture were opposed by various careerists and charlatans who lived in Russia at the time, passing as true scientists and men of art.

After his death many scientists from the nobility and the bourgeoisie. not to mention the ideologists of Russian orthodoxy, continued to slander this great fighter for progress in science and culture.

An all-round study of Lomonosov's life and work however gives the lie to their malicious attacks. Historians of the Lomonosov Museum at the U.S.S.R. Academy of Sciences have produced a thoroughly documented work. containing a virtually day-by-day account of his life. One is amazed to read how many difficult problems Lomonosov was able to solve in the course of a single day and how hard and intensively he worked. Evidence of this is also contained in his numerous reports on the work he had accomplished in the course of three months, or a year. Here is an example. In a report to the Academy covering his major accomplishments in 1756 Lomonosov wrote:

"In chemistry: (1) apart from various chemical experiments, described in a diary of 13 pages, other experiments were conducted during which metals were annealed in sealed glass vessels in order to ascertain whether metal increases in weight as a result of heat; these experiments showed that good Robert Boyle had erred, for without outside air the weight of annealed metal did not change; (2) the results obtained during experiments with annealing metals in vessels from which the air had been pumped out have never before been registered by scientists."** In physics I have completed a splendid invention—a night spy-glass and several other scientific instruments. I have finished a work called *Report on the Origin of Light Pro-*

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* M. V. Lomonosov, *Complete Works*, Vol. 10, pp. 545-46.

** Ibid., pp. 392-93.

pounding a New Theory of Colours which I have read at a public meeting of the Academy of Sciences."

In history: "...I have studied 15 volumes of Russian historical manuscripts, which I had collected in the current year for my library, so as to compare their descriptions of historical events."[*] Lomonosov also composed an epic poem *Peter the Great*, and worked hard on *On the Earthquake Origin of Metals, On Infinitely Small Insensitive Physical Particles Constituting Natural Substances and Containing an Adequate Basis for Specific Properties*, and other papers which he had begun earlier. At the same time he was giving much attention to the stained glass factory at Ust-Ruditsk and to the enormous day-to-day work at the Academy, all of which shows that he had no spare time and worked purposefully and in an organised manner. In addition proof of this may be found in a letter to I. Shuvalov, of January 4, 1756, in which he wrote that he was working on his *History of Russia* and regretted that he had no time to carry out the experiments he had planned in chemistry, physics and other natural sciences, or to devote his hours of rest to them. "Everybody is entitled to rest," he wrote, "and people relax after work by playing cards, chequers, or other games, or smoking with their guests or relatives. Finding all this tedious, I have given up such pastimes long ago. Accordingly, I hope that I shall also be permitted to relax after working on my *History of Russia* and on perfecting the Russian language, but instead of playing billiards I shall spend a few hours a day carrying out physical or chemical experiments, which are not only an excellent pastime ... but will no doubt benefit and glorify our country to no less an extent than my *History of Russia*."[**]

The blame for Lomonosov's premature death should be laid at the door of those who baited him and made his living and working conditions intolerable. There are many facts proving this point. For instance, when Lomonosov was ordered to write a history of Russia, Schumacher and his followers used this as a pretext for evicting him from his flat and barring him from the chemical laboratory. It was only Lomonosov's northern hardiness that enabled him to endure the numerous privations and a quarter of a century of intensive work at the Academy.

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[*] Ibid., p. 393.

[**] Ibid., p. 475.

P. Sakulin, a champion of the autocracy, also made much of Lomonosov's alleged bad manners. "Lomonosov's manners," he wrote, "were quite uncultured, and consequently, it was easy to find fault with him from the standpoint of our present moral and cultural principles. We must not forget, however, that many of his traits were characteristic of the morals of the time, and bear in mind the principal thing that passions and vices in the psychology of a great man have quite a different significance from what they have in the psychology of an ordinary person."*

Another trend in the assessment of Lomonosov's ethics reveals an undercurrent of religion. Professor of Theology A. Preobrazhensky in an article entitled "The Moral Make-up of M. V. Lomonosov and Some Basic Features of His Philosophy" attempts to identify Lomonosov's moral principles and ideals with religious morals and claims that his many-sided scientific activities were a continuous service to God.

"For Lomonosov," he wrote, "science is not just a professional craft but the fulfilment of his lofty destiny, the way to spiritual ennoblement and moral self-creation of the personality, the way to uprooting superstitions and prejudices. It is a 'task consecrated to God', a form of worship. And Lomonosov is not a learned craftsman, but a learned thinker whose scientific work treats of general problems of world outlook, confirms the existence and greatness of the Creator, and strengthens naive belief in God."**

Porfiryev, another theologian, endeavoured to dissolve Lomonosov's noble patriotic sentiments in religion. Ignoring Lomonosov's struggle against the enemies of the

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* P. Sakulin, *Individuality of Lomonosov* (Russ. ed.), Moscow. 1912, p. 129.

** *Lomonosov's Day in the Imperial Nikolayevsky University*, Saratov, 1911, p. 20.

Russian people, he tries to prove that Lomonosov adhered to the religious principle of not resisting evil, and sought consolation in the psalms of the Fathers of the Church.

"Religious and patriotic sentiments and love for nature and science," Porfiryev declared, "were the fountainhead of Lomonosov's poetical inspiration. At difficult moments of his life, which was filled with struggle against all sorts of privations and physical and moral sufferings, Lomonosov turned to religion and sought consolation in David's songs and the sufferings of Job: he versified general psalms and wrote an ode based on the Book of Job."*

Lomonosov was accused of copying Western ethics, especially those of Leibniz and his followers in the western countries, of spreading them in Russia and so forth. This was done for the purpose of depriving Lomonosov's world outlook of its materialist essence and of portraying him as an orthodox follower of idealistic and religious principles in ethics.

Such were some of the "principles" and methods used in the latter half of the 19th and the beginning of the 20th century to falsify Lomonosov's ethics. But the most dangerous tendency was that of dissolving his ethical principles in religious morality although those who endeavoured to do so paid lip-service to his greatness, and his "services" to the Orthodox Church.

The Holy Synod of Lomonosov's time, however, held a different view of his morals. The feudal clergy of those days, not without reason, were apprehensive of his activity and works, which were undermining the ideological principles of religious philosophy, including religious ethics, and they waged a sharp struggle against him. But after his death many ministers of the church revised their appraisal of his ethical principles and began calling them religious in an effort to curb their fructifying effect on progressive sections of Russian society.

But Lomonosov's moral ideals continued to influence the minds and hearts of the advanced people of Russia in face of all attempts to vilify or misrepresent them. A. Radishchev, A. Pushkin, V. Belinsky, A. Herzen, N. Chernyshevsky and many other advocates of progressive philosophy and ethics thought highly of Lomonosov's moral principles and continued his best traditions.

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* *M. V. Lomonosov.* Collection of historical and literary articles (Russ. ed.), Moscow, 1912, p. 611.

The great 19th-century Russian revolutionary democrat and thinker N. Chernyshevsky repeatedly pointed out that the principal, determining aspect of Lomonosov's creative activity was his selfless service to the people of Russia and the ardent desire to promote her progress. "Lomonosov had a passionate love of science," he wrote, "and yet he concentrated his thoughts and attention exclusively on what was needed to advance the prosperity of his country. He wanted to serve only his country and not pure science."[*]

Although Lomonosov did not write any special works on ethics, his contribution to the support and development of advanced morality should not be underestimated. He outlined his basic ethical principles and norms in many works and in direct relation to the problems of promoting economy, education and science in Russia. These principles and norms are best described in his *Discourse on the Duties of Journalists When Writing an Essay or a Composition in Support of Freedom of Philosophy*, *On the Growth and Preservation of the Russian People*, *On the Duties of the Clergy*, in critical remarks on the works of the historian Müller, in many odes, literary compositions, letters, etc. Nearly all his works in some or other degree treat of ethical problems.

Lomonosov's moral principles were formed on the basis of his studies of the morals of Russian and other peoples and critical assimilation of the ethical ideas and teachings of his predecessors. In evolving a system of ethical norms he was fully aware of their great social significance.

He held that ethical norms and human morals were not age-old, inherent, or invariable, but that they changed together with conditions of life and the system of upbringing and education. "When people acquire good morals through education and the instilling of fear, crime will decrease, there will be less petitioning and calumny, the work of courts will be less difficult, and there will be fewer laws. It is good to make laws, when there is someone to observe them."* Firmly convinced that it was quite possible to communicate virtuous morals to all people, he intended to write a special work *On the Improvement of Morals and Development of Education*. To a certain degree it was this belief that explained the enthusiasm with which he elaborated and persistently demanded the enforcement of a series of measures aimed at educating and enlightening his people. He pursued the same goal in evolving an original code of ethical principles and norms.

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[*] N. Chernyshevsky, *Selected Philosophical Works* (Russ. ed.), State Publishing House of Political Literature, 1950, Vol. 1, p. 576.

Of definite interest were his thoughts that people's moral principles and actions were directly dependent on conditions of life. He wrote, for example, that serfs fled from their landlords to Russia's borderlands and to foreign countries "more often than not as a result of landlord oppression and recruitment into the army". But it must not be overlooked that he offered an idealistic solution to the problem of the ultimate sources and causes of various ethical norms, thinking that they change in accordance with the nature and level of education.

He viewed people's norms of conduct in direct relationship to specific conditions, but very rarely used these conditions to justify evil. He did not believe that people's lives and actions were always in fatal dependence on the living conditions and on nothing else, but maintained that a great deal was contingent on their will and wishes. Everyone, he said, bears responsibility for his evil deeds and immoral conduct. At the same time those who rigidly fulfil their moral duty and perform patriotic feats in the name of their people, should receive material or other encouragement, be held up as examples for others to follow and enjoy universal respect and fame.

Lomonosov, coming as he did from the very midst of the people, was convinced that people improve and acquire higher morals by performing useful work and overcoming difficulties. He maintained that by surmounting enormous difficulties, mastering the rigorous natural conditions of their country and repelling invaders, the Russian people were increasing their moral stature.

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* M. V. Lomonosov, *Complete Works*, Vol. 6, p. 407.

He had many good ideas about useful work improving people's moral qualities. He saw that inspired labour ennobles people, brings them satisfaction and happiness, and contrariwise, the idleness breeds vice. Accordingly, he held that one way of improving morals was to eliminate idleness and to create conditions conducive to normal useful work and rest. He vehemently denounced the clergy for insisting on the observance of religious rites that were causing physical and moral harm to the whole Russian nation.

In his works Lomonosov repeatedly points out that scientists and men of arts and letters who seriously and consistently work on genuinely scientific problems and do everything to improve education and culture as a rule possess high moral qualities and are real patriots. On the other hand, scientists, writers, thinkers, and other people who do not conscientiously fulfil their duties and work only for their personal benefit are guilty of immoral conduct. He put this particularly strongly in connection with the activities of the Academy of Sciences, and unsparingly denounced the treachery, careerism, money-grubbing and other unethical qualities and the unworthy conduct of the foreign ignoramus Schumacher. This persecutor of Russian science resorted to blackmail and other dishonest means to incite professors against each other in accordance with the principle of divide and rule. Schumacher, Lomonosov wrote, "provoked quarrels between professors by finding accomplices among them, by arming and encouraging younger professors against the older ones; some professors he attracted to his side by permitting them to draw their salary in advance, or by raising it, others he kept in suspense by praising them one day and reprimanding them the next, or by arbitrarily replacing them; he wormed his way into the good graces of the heads of departments and other high officials by making them gifts of excellently bound books or engravings costing thousands of rubles, or by loaning such books and engravings from the Crown Bookshop with the result that many of them were irretrievably lost. All this was done in order to preserve his absolute power at the Academy and without a thought for promoting science. . . ."*

Schumacher and people of his kind were free to act as they did because the greater part of the ruling aristocracy adhered to similar norms of conduct and plotted intrigues in pursuance of their careerist and money-grubbing inclinations with complete disregard for the interests of the people. Lomonosov did not understand the social roots of this evil and naively thought that all that was necessary to overcome it at the Academy was to get rid of people like Schumacher and Tauberg.

Lomonosov, who wanted to see a scientist's name and honour unblemished, applied advanced ethical principles in the field of scientific criticism, maintaining that critics and reviewers of scientific works should be guided by noble motives and a desire to promote scientific and social progress. He defined the tasks of journalists as follows: "What is required of them are strength and will-power. Strength to discuss all the numerous and varied problems included in their plan thoroughly and with a knowledge of the task in hand; will-power—to concentrate on nothing but the truth and not to succumb to compromise, bias or passion. People lacking these features would not have acted in the capacity of journalists were it not ... for the hunger which drove them to discuss and judge matters beyond their comprehension."**

His reviews of other scientists' works were always objective. He praised original investigations that enriched science, and insisted on their publication, and subjected to scathing, principled and scientifically substantiated criticism those works which fell short of the mark and contained errors. Lomonosov's reviews of two works by Professor S. Krasheninnikov excellently illustrate this point. After carefully reading Krasheninnikov's *Description of Kamchatka* he wrote: "...I consider this work worthy of publication because of the wealth of information it contains about one part of the country. The small number of unimportant stylistic errors in it can be corrected by the author himself as he prepares it for print and are in no way an obstacle to its publication."*

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* M. V. Lomonosov, *Complete Works*, Vol. 10, p. 45.

** Ibid., Vol. 3, p. 218.

Another work *On the Usefulness of Sciences and Industries in All Countries* by the same author elicited a totally different response. Lomonosov pointed out that this work, which was intended originally as a speech to be delivered at a meeting of the Academy of Sciences, "inadequately treats of the correct application of sciences. Furthermore, the goals of some of them are set down incorrectly. For example, in this speech geography is assigned the role which is typical of astronomy. There are other shortcomings in his reasoning concerning the importance of matter ... these shortcomings must be eliminated. Bearing all this in mind I think that although this speech might be delivered, it would be best not to have it published and in this way safeguard the honour of the Academy and its author. . . ."**

When a work under review contained shortcomings and mistakes which detracted from the honour and dignity of the Russian people Lomonosov criticised it unsparingly. This was his attitude to Gerhard Müller's thesis *On the Origin of the Name and the People of Russia*. A work on this subject, Lomonosov wrote, "should contain nothing which would arouse the resentment of Russian listeners, and make them indignant and hate the Academy. But I think that after hearing this thesis in which a totally new construction based on nothing more than conjectures is put upon their origin, a work which claims that their name is of Finnish origin, and, disregarding their ancient history, asserts that they were frequently defeated by the Swedes who drove them off into slavery and brought ruin and devastation to their land, something about which the Russian people had never heard before, they will not only be righteously indignant with Mr. Müller but also with the Academy and those who stand at its helm".***

An indispensable criterion in making an appraisal of scientific and artistic works, according to Lomonosov, was the extent to which they influenced morals. In this respect papers treating of social sciences and literary and artistic works were particularly important. He himself devoted a great deal of attention to problems of education and the improvement of morals in his social and political, linguistic and artistic works. It was from these positions that he assessed the works of progressive French thinkers and men of arts of his day. With regard to France, he wrote: "We have every reason to doubt that it was her might that won her the respect of many countries and not her sciences, particularly linguistics, and her splendid writers who by dint of hard work purified and enriched the French language."*

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* M. V. Lomonosov, *Complete Works*, Vol. 9, p. 632.

** Ibid., p. 630.

*** Ibid., Vol. 6, pp. 41-42.

Progressive social sciences foster lofty ideas and ambitions in young minds, whereas great evil is caused by people who uphold spurious ideas in literary works. "...Enormous harm," he wrote, "is caused by people who write nonsense in an effort to win a name for themselves, and by criticising the best works to raise themselves above other writers; furthermore, their unripe works lead astray young people starting out as scientists, and invest untrained minds with false concepts which it is difficult or altogether impossible to eradicate."**

Lomonosov's creative activity organically combined his constant desire to promote science in Russia with energetic work to spread its achievements among the masses. All this fused into a single patriotic ambition to contribute to Russia's development and enhance the glory of the Russian people. He attached great significance to the role played by patriotic sentiments in the successful solution of problems stimulating Russia's progress. Only patriots could sacrifice themselves to defend their country against foreign oppressors and promote her development. Lomonosov despised those who ignored their sacred duty to serve their people and uphold its interests. It was no accident that patriotism was one of Lomonosov's chief ethical principles. The whole of his versatile activity had a clearly defined patriotic tendency. From passionate defence of the honour and dignity of the Russian people to concern for the development of Russian science, his entire activity was permeated with the single thought—to be indefatigable in fostering the well-being and culture of his people and his country. He dreamed of seeing Russia among the advanced countries of the world, a land where all people would be prosperous, educated and possess just social laws.

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* Ibid., Vol. 7, p. 581.

** Ibid., p. 582.

In a letter to G. Teplov in 1761, Lomonosov declared that he had always exercised "patience, lofty stubbornness and courage in surmounting the obstacles that hinder the spread of knowledge in the country", and that he would continue to do so to attain what he "prized ... the most" in his life. Further he wrote: "I would not hold it as a sin against anyone for rising even against his own father if he does it for the common good and especially for the promotion of science in Russia."*

Indeed Lomonosov courageously and steadfastly upheld the honour and dignity of his people by waging an unremitting struggle against all foreign as well as Russian scientists who humiliated the Russian people, vilified them and considered them incapable of independent creative activity. He was firmly convinced that given the possibility for the unhindered development of their talents and assimilation of knowledge and culture, the gifted Russian people would cope with all the difficulties connected with the enforcement of social transformations and the rise of science and culture. A manifestation of the talent of the Russian people, according to Lomonosov, was the rich and vivid language they had created. In his *Russian Grammar* he spoke very highly of the Russian language but at the same time stressed the need to continue perfecting it. "The language with which Russia rules over a great part of the world ... is naturally copious, beautiful and expressive," he wrote, "and not inferior to any other. Therefore, there is no doubt that it can be perfected and attain the level with which other languages amaze us. Thus hopeful I have written this composition, but more with the intention that this small contribution to the Russian language would inspire others boldly to continue perfecting it."[*]

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* M. V. Lomonosov, *Complete Works*, Vol. 7, pp. 548, 554.

He believed that to achieve this goal it was necessary first to "improve the morals" of Russian people through education. To attain this "terrible obstacles will have to be surmounted, which, however, will be no more dangerous than forcing people to shave their beards, wear foreign dress, be polite to the heterodox, force sailors to eat meat during summer fasts, dispose of the boyars, the patriarchate and the *streltsi*, and in their place institute the Ruling Senate, the Holy Synod and a new regular army, to transfer the capital to an empty place and the New Year to a new month. *The Russian people are resilient!"* (Italics by the author—*Ed.*)[**]

Lomonosov felt himself morally obliged to work honestly and selflessly to turn the Academy of Sciences into an institution directly fulfilling its duty to science and culture in Russia. He wrote that "the founding of the Imperial Academy of Sciences not only benefits the whole country and enhances its glory, but also improves the well-being of all humanity with new discoveries that become known in all parts of the world, a fact which is borne out by Academicians abroad".[***]

A major task confronting the Academy, Lomonosov maintained, was to spread scientific and cultural achievements among the masses. Scientists should not shut themselves up in a closed circle of purely scientific interests and keep aloof from the rest of the people. He believed that the "Academy was in a position not only to ensure scientists for itself, but to train specialists for the whole of Russia".[****] With this aim in view he made repeated attempts to improve the work of the Academy. All his thoughts, suggestions and intentions on the matter are fully described in his *On the Necessity to Reorganise the Academy.*

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[*] Ibid., p. 92.

[**] Ibid., Vol. 6, p. 396.

[***] Ibid., Vol. 10, p. 47.

[****] Ibid.

Prior to defining fundamental measures for radically improving the work of the Academy, he considered it necessary to describe its deplorable state and to find out what had caused it. "The two principal reasons for the unsatisfactory conditions at the Academy," he wrote, "are: first, the Academy Administration consists of poorly educated people who sought for and were given this office; second, the ill-will encountered by Russian students during studies, and neglect for their living conditions. All this caused great harm to the Academy before and after the introduction of new laws."* The manifestly bad conditions at the Academy were a source of anxiety to Lomonosov primarily because this institution of higher learning, the biggest in the country, was rendering altogether insufficient assistance to the Russian people in developing their own sciences. He viewed the domination of foreigners at the Academy, who were not interested in promoting Russian science and culture, as a real calamity, greatly hindering the improvement of its activities.

Lomonosov said that he "endured uncalled-for and unbearable disappointment in his fight to turn the Academy into a centre for training Russian scientists and specialists. "...Schumacher," he wrote, "was afraid of Russians making progress in science and becoming professors, because that would have undermined the power he wielded. Russian students were, therefore, treated with a negligence making it apparent that he had no intention of giving them a real education. This becomes all the more obvious from Schumacher's oft-repeated phrase: 'I made a great mistake in approving Lomonosov's professorship.' Not long ago his son-in-law, heir to his property and activity and almost to the Academy itself, made the following remark in a conversation dealing with the promotion of Russian students: 'Do we need ten Lomonosovs? One is a burden enough!' "** The policy pursued by those who were actually in control of the Academy elicited Lomonosov's vigorous opposition and failed to quench his desire to serve his country to the best of his abilities.

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* M. V. Lomonosov, *Complete Works*, Vol. 10, pp. 43-44.

** Ibid., p. 46.

With courage and decision he surmounted the numerous obstacles put up in his way by incoming foreigners, and constantly worked "for the increasing the number of scientists and the spread and flourishing of science in Russia".[*] He dreamed of the time when a scientist would be free to live, work and to carry out daring experiments.

He maintained that the Academy can fulfil its true purpose only if both its rank-and-file membership and the Administration consisted of honest, efficient people capable of stimulating the development of science. He considered that a person elected to the post of Conference-Secretary should be "a man well-known for his conscientiousness and services, whose firmness and industriousness will ensure this eminent association not only internal calm and concord, but also active scientific connections with foreign academies and the whole scientific world, and timely publication of our works".[**]

Lomonosov believed that encouragement, including material incentive, for good work and achievements in science and culture should become a general ethical principle; bad work, ethical misconduct, not to speak of crimes, must be denounced, publicly censured and punished. One of the main points in the new laws he had drawn up for the Academy, said: "To encourage the good and to instil fear in the evil it is necessary to lay down awards for services rendered, and punishment for misdeeds."[***] He demanded equal remuneration for all Academy professors, and that it should be increased only in accordance with the importance of their scientific achievements. "Every branch of knowledge at the Academy is equal," he wrote, "and in each there may be professors having equal or different knowledge of the subject, for among them there may be outstanding physicists, botanists, mechanics or other specialists, or poorly educated people; moreover a person may be excellently versed in many sciences but assigned to only one of them. Thus, generally speaking, all professors must receive equal remuneration which can be increased only in accordance with their services, for it is unfair that such a great botanist as Carolus Linnaeus receives 860 rubles while the mediocre professor of higher mathematics who was recently recommended to us is paid 1,800 rubles. Furthermore, because of the unequal salaries, many students take up sciences such as higher mathematics, which are more remunerative and which can be pursued while sitting in his own room or during strolls in a garden. A chemist receives 860 rubles and has to work amidst coal, soot and injurious gases."*

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[*] Ibid., p. 35.

[**] Ibid., p. 318.

[***] Ibid., p. 48.

Aristocratic and bourgeois interpreters of Lomonosov's ideology wrongly attribute solely to personal ambition his efforts to be made an Academician, to be included in the Academy Administration and to acquire the title of Councillor of State. It was unfortunate that he had to fight for recognition of his great services, a well-earned increase in salary and improvement of material conditions for his family and himself, but in doing so he was prompted first and foremost by a desire to uphold the honour and dignity of his country and the prestige of science in Russia. When in 1759 he wrote to Count V. Vorontsov of the need to institute the post of Vice-President of the Academy and asked to be appointed as such, he motivated his request first of all by the fact that the Academy had many institutions, departments, etc., and, second, by the frequent absence of Count K. Razumovsky, the nominal President of the Academy. In this case, too, Lomonosov's prime concern was for the interests of the Academy and its development, and to prevent persecutors of Russian science from entrenching themselves in the Administration. "...In doing so," he wrote, "I seek nothing else but to put an end to the Academy's inherent shortcomings."**

He pointed out that in view of Count Razumovsky's prolonged absenteeism "it is necessary to institute a special office, because I am placed at a disadvantage by the presence of two foreign members in the Administration, who, I feel, are using it to retard the education of Russians. The Great Academic Corps consisting of many departments must have a Vice-President without fail, for this office has been instituted in many smaller organisations. But should someone outside the Academy be appointed to this post it would be a useless measure, because he would require a long time to master the inner workings of the Academy and would have to listen to the opinions of other people at the Academy, who, as is known, do not see eye to eye. On the other hand, considering that I have been occupying various posts at the Academy for 20 years, that I am a Councillor of State of nine-years' standing, that I have been a member of the Administration for three years already, and that previously I served as an arbitrator on some of its committees and, moreover, that I have occupied different professorial posts and consequently have been in a position to study what the Academy has in abundance and what it lacks, I consider myself fully justified in humbly begging to be promoted to this office and thus demonstrate my sincere and inherent love for my country and sciences that is uppermost in my heart."*

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* M. V. Lomonosov, *Complete Works*, Vol. 10, pp. 50-51.

** Ibid., p. 553.

This letter frankly states all the qualities that were required not only of a Vice-President but also of the President of the Academy. Lomonosov possessed them all, and there can be no doubt that, had he been appointed Vice-President, or better still, President of the Academy, it would have benefited the whole of Russian science. But it was against the interests of the court nobility and the foreigners who supported it to have a scientist of such integrity and advanced views in charge of the Academy.

When Lomonosov petitioned for an increase in pay, or to be given the rank of Councillor of State, he was not in the least motivated by egoistic sentiments. For example, after Teplov, whose services could in no way be compared with Lomonosov's, was made Councillor of State, Lomonosov approached the Academy President with a request that he, too, be granted this title. In those days a Councillor of State carried great weight in the Academy and could decisively influence the solution of all sorts of problems. At first the President agreed but when Lomonosov's enemies heard about it they spared no effort once again to humiliate him. "Hearing of my request," he wrote, "Councillor Tauberg with the help of Professors Epinus and Zeiger and Assistant Professor Kelreuter, the latter a favourite of Tauberg and Müller, prevented it from being fulfilled. Led by Epinus, with Zeiger as spokesman, they came all together to the President and some other people and asked that there be no promotion for Lomonosov. That is why he has not received it, in spite of the fact that he has been without promotion for nine years, that he has a 30-year service record and has held four professorships in addition to his work in the Administration. At the same time the title of Collegiate Councillor has been awarded to Epinus, who has been working here less than three years on contract although he has rendered no service whatsoever to Russia."[*]

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* Ibid., p. 536.

There were people who accused Lomonosov of money-making intentions when a tract of land with 211 peasants living on it was handed over to him for the construction of Russia's first stained glass factory. A study of the history of the construction and work of this factory shows that it brought him no profit at all, and that he invested a great deal of effort and time in this enterprise. He repeatedly requested to be allowed to defer reimbursement of the loan he had received to build it. In a letter to the Senate in 1759 he wrote: "Having expended all my strength and finances to launch the production of mosaics, I have been unable to organise the production of other commodities at the factory that would have yielded enough profit to allow me in time to repay the loan of 4,000 rubles to the Office of the Manufactur-Collegium, for at present we receive no private orders for mosaic portraits. This causes great harm to the factory. . . ."[**]

Lomonosov's whole life proves his unselfish desire to improve sciences and education in Russia. He called for a free union of true scientists, for collectivism and cooperation in scientific work. In those days intrigues, careerism and enmity were rife in the Academy. Its regulations prevented professors from taking up problems other than those directly related to their speciality, thus preventing the establishment of close co-operation between them. "In this way," Lomonosov wrote, "not only necessary contacts are cut short, but also the alliance of sciences and the friendship of scientists becomes impossible. It often happens that an astronomer needs the counsel of a mechanic or a physicist; a botanist or an anatomist seeks the advice of a chemist ... etc. For the sake of fruitful work scientists must always take counsel with each other and maintain friendly contacts. Moreover, is it against the nature of sciences that an anatomist should know chemistry and write about it? Or will it detract from his merits if he communicates the results of his discoveries to a chemist? In order to ensure the freedom and alliance of sciences, scientists should exchange information and permit its unhindered application. Chemistry is the eyes of mathematics and the hands of physics. And so, if a physicist has no eyes or hands of his own, he must borrow them from others. But one's own serve one better and there is no forbidding their use."*

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[*] M. V. Lomonosov, *Complete Works*, Vol. 10, pp. 292-93.

[**] Ibid., Vol. 9, p. 144.

One form of co-operation of scientists, Lomonosov maintained, should be joint discussions of works ready for publication. "Associations of scientists," he wrote, "should subject to a strict, all-round analysis all the works of their members prior to their publication and prevent them from mixing erroneous concepts with the truth, presenting ordinary conjectures as proof, or the old as the new."**

Scientists must also participate in businesslike, creative discussions. Lomonosov himself took an active part in scientific debates at the Academy and in periodical publications, displaying a serious, honest and comradely attitude to the ideas of genuine scientists. His ties with Euler, Richmann and others are examples of his co-operation with the advanced scientists of his day. At the same time he called for a principled, uncompromising struggle, irrespec-

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[*] Ibid., Vol. 10, p. 57.

[**] Ibid., Vol. 3, pp. 217-18.

tive of persons, against anti-scientific works whose authors wanted to disparage Russia and her science.

Lomonosov won the support of many Academy scientists in the polemic that flared up around Müller's *On the Origin of the Name and the People of Russia* with the result that this work was severely criticised and remained unpublished.

Lomonosov opposed the vilification of scientists and strove to draw all other men of learning into the fight for scientific integrity. In 1752, the *Leipzig Journal* ("Notes on the Achievements of Natural Sciences and Medicine"), Volume II, Part 2, carried a review of the first volume of the *New Commentaries* of the Petersburg Academy of Sciences published in 1750, which included *Meditations on the Origin of Heat and Cold*, *An Essay on the Theory of the Elastic Force of Air* and other works by Lomonosov. The review was biased and scientifically unsound, and prompted Lomonosov to write his *Discourse on the Duties of Journalists.*

He reported the contents of his work at an Academy meeting which passed the following resolution: "Lomonosov has read to us his reply to the editor of the journal. In view of the fact that the review heavily criticises Lomonosov's theses published in the first volume of the *New Commentaries* and that it is obvious that the reviewer misunderstands much of what they contain and ascribes to Lomonosov ideas which the latter refuses to accept as his own, Lomonosov considers it necessary to confront this slander with these objections which are intended for publication; this measure has the approval of other Academicians."*

Thereupon Lomonosov sent his work with an accompanying letter to Leonhard Euler at the Berlin Academy of Sciences and urged him to join the struggle against such calumniators of science. With the assistance of Leonhard Euler and Jean Henri Samuel Formey this work was published in the journal (Volume II, 1755).

Lomonosov repeatedly declared that only vigorous, scientifically argumented criticism would protect real scientists against those who vilified them and suppressed freedom of creative thought. He considered it the sacred duty of all honest scientists and men of culture "to oppose such reprehensible acts with all their strength", and added: "If such an attitude with regard to those who are striving to benefit sciences is maintained in the future, it may result in their utter frustration, thus causing considerable detriment to the commonwealth of scientists. If this were to pass it would first and foremost signify the complete downfall of the freedom of philosophy."*

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* M. V. Lomonosov, *Complete Works*, Vol. 3, p. 540.

His work defining the duties of journalists may be legitimately called a code of ethical principles and norms of conduct for scientists and men of arts and letters.

Lomonosov opposed all those who turned freedom of creative endeavour into an instrument for attaining narrow careerist goals. Scientists and all men of letters and arts, he held, must enjoy definite freedom in their work and each one of them should work towards the establishment of this freedom. He had great respect for Descartes and other scientists who championed unhampered development of philosophy and other sciences and their complete emancipation from scholasticism. "It is common knowledge," Lomonosov wrote, "that science had made rapid and substantial progress since it cast off the chains of slavery and replaced them by freedom of philosophy."**

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* Ibid., pp. 229-30.
** Ibid., p. 217.

Chapter VIII

ATHEISTIC TRENDS IN LOMONOSOV'S WORKS

To complete this outline of Lomonosov's philosophy we must finally examine the atheistic trends in his works, a field in which many proponents of idealism and religion have been at pains to distort his ideas.

If Lomonosov's philosophy is viewed in its entirety, with particular attention to its principal, decisive aspects, treating of cognition of nature, we shall see just how irreconcilably it contradicts the religious interpretation of the world. Napoleon, after reading *Heavenly Mechanics* by the great French scientist Pierre Simon Laplace, asked the author why there was no mention of God in it. Laplace replied that he had felt no need for such a hypothesis. Lomonosov also did not require the assistance of religion in studying the innumerable phenomena of nature. He declared outright that it was impossible to explain physical and other processes of the material world with the help of the Psalter. The occasional references to God or Providence in his works have absolutely no bearing on his investigations or theoretical generalisations.

Yet even today the advocates of religion, overt and covert, are endeavouring to reconcile Lomonosov's philosophy with religion or completely dissolve it in the latter. During Lomonosov's lifetime the higher clergy of tsarist Russia supported by reactionary courtiers and foreigners were well aware of the danger to which his scientific philosophy exposed religion and the Orthodox Church. The church in these days settled accounts with its opponents easily and without ceremony. In 1769, Lomonosov's pupil Anichkov, who worked at Moscow University, wrote an atheistic book entitled *Discourse on Natural Theology and on the Beginning and Origin of Natural Divine Worship*. Without a second thought the clergy burned it in a public place in Moscow and through the agency of the Holy Synod obtained the passage of a resolution, which read in part: "Moscow University is instructed ... to prohibit publication of such works, and to see to it that lectures contain nothing that could incite people to violate the law ... and that force should be applied to preserve law and order."*

Lomonosov's conflict with the church dignitaries was precipitated not only by his poem *Hymn to the Beard*, written and circulated in Moscow in 1757. Its causes have deeper roots—in the atheistic character of all his works. As regards the *Hymn to the Beard*, it was nothing more than a direct pretext for an open offensive on Lomonosov by the priests. Probably the reason that no attempts were made to reconcile his philosophy with religion at the time was that Lomonosov would have been well able to repulse all sorties.

After his death, the ideologists of the Orthodox Church altered their tactics. Realising that Lomonosov had attained widespread popularity in Russia and even in Western Europe, the ideologists of Russia's ruling circles decided to use his ideas in their own interests. These tactics were employed with particular zeal in the latter half of the 19th and the beginning of the 20th century, at the time when in their struggle against the monarchist-landowner system revolutionary democrats and other progressives in Russia were defending and developing Lomonosov's best traditions. The growing achievements of science were making it more and more difficult to reject materialist theories outright.

Far-sighted theologians, and scholars who shared their views, were forced to recognise many achievements in the natural sciences, while giving them a religious colouring.

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* M. Sukhomlinov, *History of the Russian Academy* (Russ. ed.). Vol. I., St. Petersburg, pp. 201-02.

In the second half of the 19th century this trend found its fullest expression in the works of V. Solovyov, and since there is a tendency to regard him as the direct heir to the "religious element" in Lomonosov we must examine the basis of his conceptions.

Solovyov begins with an attempt to prove that he recognises the achievements in natural sciences, and does not doubt the objective existence of nature. "A stone exists," he writes, "a plant exists and lives, an animal exists and, in addition, is conscious of its life in its actual states, a human being perceives life's purport with the help of ideas, God's sons carry this purport or perfect moral order, into life in everything."* He even recognises the existence of consciousness in highly-developed animals. "Denial of the existence of consciousness in animals," he points out, "indicates nothing more than an aberration of human consciousness in some philosophers. One comparative anatomical fact will suffice to correct this glaring error.

"A denial of the consciousness of animals reduces their life to the blind suggestion of instinct. But if that is so, then how can we explain the gradual development of the organ of conscious spiritual activity—the brain—in higher animals? How did this organ appear and develop in animals if they do not have the corresponding functions. *Unconscious*, instinctive life does not need a brain, as is shown by the fact that it appears prior to this organ and reaches its highest degree of development precisely in creatures that have no brain. The predominance of social, predatory and artistic instincts in bees and ants is obviously not connected with the brain which, strictly speaking, they altogether lack, but with nothing more than peritoneal ganglions ... which are indeed extremely well-developed in them."**

At first glance it might seem that Solovyov has a firm scientific understanding of all these problems, but he is actually leading up to religious conclusions. Defining the nature of man, for instance, he writes: "Man differs from animals not in that he has consciousness, which is not lacking also in the latter, but in that he has the ability, or the intelligence to assimilate general concepts, or ideas. Direct proof of the consciousness of animals are their purposeful movements, expressions and their language of sounds: radical proof of man's intellect is language, which not only expresses a certain state of consciousness but the general sense of all things. Ancient wisdom has legitimately defined man not as a conscious being, a far from adequate description, but as a speaking or intelligent being."* Further on, however, he reaches a purely religious conclusion. "The inherent ability of the intellect and language to comprehend the supreme all-embracing truth in the multiformity of things," he writes, "was manifest in peoples living in isolation from each other and gradually led to the formation of the human kingdom on the foundation of the animal kingdom. The ultimate essence of this human kingdom consists in the ideal *demand* for a perfect moral order, that is, the demanding for the kingdom of God. Two roads, the prophetic inspiration of the Hebrews and the philosophical thinking of the Greeks, led human spirit to the idea of the kingdom of God and to the ideal of God-man."**

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* V. Solovyov, "Reality of Moral Order." *Problems of Philosophy and Psychology* (Russ. ed.), 1896, Book 1 (31), p. 116.

** Ibid., p. 118.

The above discourse shows how the learned assistants of the clergy had to manoeuvre between science and religion. In the process they endeavoured to portray Lomonosov as a scientist who placed science at the service of religion.

Before "proving" the religious character of Lomonosov's philosophy, the upholders of the Orthodox Church decided to embellish the ideological content of the Orthodox faith in order to portray its holy fathers, in the person of Vasily the Great and Ioannes Damaskenos, as proponents and devoted supporters of science, truly an incongruous role as far as these two men were concerned. The implication was that the Orthodox Church, as opposed to the Catholic Church, had never persecuted science but, on the contrary, had always patronised it and established favourable conditions for the creative work of scientists.

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* Ibid., p. 118.

** Ibid., p. 119.

The task of substantiating this extremely reactionary conclusion was undertaken, strange as it might seem, by the natural scientist D. Galanin. He begins by claiming that truth, beauty and so forth are disclosed in the Scriptures. At the same time he holds that the Bible, the Gospel and all the works of the "fathers of the Church" are not to be taken literally, and that they contain a special meaning and so forth which will be revealed to those who make a thorough study of them. At this point science is supposed to step in and, by drawing on its multitude of methods, help solve the problem.

Accordingly, Galanin writes that a study of the Bible, the Gospel and theological treatises "requires interpretation, elucidation and elaboration: it confronts us with a range of problems and doubts which narrow the gap between religious and scientific thinking and between natural physical phenomena and juridical relations between peoples. What the universe is and how it was created is a question which interests not only scientists but also frequently perturbs the man in the street. The Bible treats of this question but it is doubtful whether it offers the correct answer. How are we to understand the Scriptures?

"The Western Church understood them literally and thus rejected the possibility of studying nature more profoundly and also, so to say, compressed the thought of the investigator, locking it up in the narrow confines of the obsolete philosophy of Aristotle. The Eastern Church had a broader outlook on the matter and its great mentors, Vasily the Great and Ioannes Damaskenos, decreed that the language of the Bible should not be understood literally but in conformity with scientific investigations, which should be searched for a basis on which the understanding of the Biblical text should rest. According to the fathers of the church, science and religion should blend in a consonant hymn glorifying Divinity."*

So Galanin makes a magic sign and the Orthodox Church, the vicious ideological enemy of genuine science, is transformed into a mighty patron of scientific investigations and scientists.

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* D. Galanin, *Lomonosov, the World-Renowned Genius of Russian Culture* (Russ. ed.), Moscow, 1916, pp. 81-82.

Theologians and reactionary scientists used this very strange conception, which was not and could not be proved even if its authors had attempted to do so, as a basis for assessing Lomonosov's philosophy. On the assumption that the purpose of science was merely to demonstrate the greatness of God through a study of his "creations", the entire creative activity of Lomonosov, who had penetrated deep into nature's secrets, was to be regarded as an act of worship.

Archpriest N. Bogolyubsky, Professor of Theology at Moscow University, said on the occasion of the bicentennial of Lomonosov's birth that the very appearance of Lomonosov was a special and an extremely rare gift of Providence. "We lack sufficient proof," he went on, "to consider him a mere product of natural or historical factors: the appearance of such men is as unexpected as it is essential to the development of consciousness and the progress of humanity. When creating a genius, nature evidently makes an inexplicable leap in its evolution thus performing a kind of miracle."* After portraying Lomonosov as a creation of God, Bogolyubsky tried to show that the entire activity of this brilliant thinker was a service rendered to the Orthodox Church. "Moscow University," he continued, "deeply cherishes the memory of Lomonosov as both the father of our Russian science and the man who was directly responsible for the founding of the University. All Russia knows him as her great citizen who gave all his brilliant talent and strength to help her prosper and assimilate world culture, and who died with lofty dreams of her future spiritual growth and greatness. The church itself joints the general celebrations by recollecting in prayer the eternal memory of Lomonosov—an outstanding pupil of its school, stimulator of spiritual enlightenment and unforgettable extoller of the greatness of God."**

Tukalevsky, another servant of the church, is more subtle and views this question from what might be called original philosophical positions. At first he reduces Lomonosov's philosophy to idealism of the rationalistic trend, and then to theology. This is how he understands the basic principles of Lomonosov's world outlook: "Lomonosov uses reason to prove the existence of God, and on the basis of reason enlightened by science he explains the origin of the universe and of man. God, the universe and man are an indivisible whole fulfilling a single purpose in accordance with the will of God himself. This unity is prescribed, pre-established by God himself, so that the harmony of the world, its beauty may become a source of gratification to those who perceive this harmony. This understanding is what distinguishes reasonable beings from the unreasonable." Tukalevsky goes so far as to belittle some religious dogmas and rites for the express purpose of "proving" the religious character of Lomonosov's philosophy.

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* *Celebrations Marking the Bicentennial of M. V. Lomonosov's Birth at the Imperial Moscow University*, 1912, p. 1.

** Ibid., pp. 2-3.

"Everything is of value in the world, everything bears signs of the Divinity," Tukalevsky wrote, "everything lives, everything is spiritualised. And this is what gives rise to Lomonosov's religion. Not religion which worships the Divinity in the narrow confines of laws and rites (Lomonosov substituted 'religion of the church' for 'religion of the individual'); but religion which makes us sense the mysterious chain ... linking man with the inglorious world, the vegetable world, the heavenly suns and with God himself. And Lomonosov sensed this connection both in the invisible temple of science whose priest he was, and in the great, immeasurable and boundless temple of nature where he acknowledged himself a participant in a solemn service to the world."*

Thus by declaring that Lomonosov substituted for the religion of the church a "religion of the individual", Tukalevsky with a flourish of the pen makes short work of Lomonosov's merits as a scientist.

We are asked to believe that Lomonosov elaborated his theory of light not on the basis of a thorough investigation of light phenomena occurring in nature, but as a result of studying the Bible. Let us hear what Tukalevsky himself says in this connection: "During moments of revelation Moses wrote in a book of the Bible: 'In the beginning God created the Heaven and the Earth. And the Earth was without form, and void; and darkness was upon the face of the deep. And the Spirit of God moved upon the face of the waters. And God said, let there be light. And there was light.' These words precisely indicate the origin of light. Lomonosov knew these words."*

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* V. Tukalevsky, *The Principal Aspects of Lomonosov's World Outlook*, p. 19.

It was "theories" of Tukalevsky and his kind that Lomonosov had in mind when he wrote: "...such discourses greatly harm the development of sciences and. consequently, our knowledge of the terrestrial globe, particularly our knowledge of mining, although certain people find it easy to become philosophers by doing nothing more than learning the words 'God made it so' by heart and quoting them instead of describing the real causes."

With a view to portraying Lomonosov as a true servant of religion, Tukalevsky alleged that Lomonosov "had never called himself an atheist" without even taking the trouble to prove this point. "On the contrary," he wrote, "Lomonosov exerted all the power of his reason to come closer to comprehending the Creator. Like Leibniz who protested against the sweeping tide of atheism, Lomonosov himself turns to God."**

Tukalevsky even claims that the texts of the psalms coincide with Lomonosov's views, and goes as far as to call Lomonosov, who had versified the 216th Psalm, as its author. Such fabrications were intended to lend a semblance of truth to the falsification of Lomonosov's views. Yet, a careful study of Lomonosov's *Rhetoric* discloses that in it he quotes passages from the works of other authors, including excerpts from the Bible and other religious books. Accordingly, the various examples, say of syllogisms, cited by Lomonosov in this work, cannot be considered as an expression of his own thoughts.

In the article *Science and Religion in Lomonosov's Philosophy* whose publication was timed to coincide with the bicentennial of Lomonosov's birth, A. Popov claimed that Lomonosov was perhaps the first man ever to regard science as a "true and inseparable friend" of religion.

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* Ibid., p. 19.

** Ibid.

Lomonosov allegedly "regarded science through the prism of religion and did not abandon this opinion for a long time, in spite of the fact that he was a free-thinking man. People of the old stamp rejected science as an enemy of religion, and called it 'profane'. Lomonosov solemnly proclaimed science a 'friend of religion' and scientific work a 'sacred' occupation. 'Studying nature is a difficult and yet pleasing, useful and sacred task,' he declared." This is how Popov described Lomonosov's view on science. And there is no end to the rehashing of this theme.

"He accepted the new science as a religion, as a new organ of religious creativity and his service to it became the feat of his life," Popov thunders. "Hence, science never became his professional occupation as it was for the German scientists, but turned into a living religious task, a kind of worship of God. Herein lies the source of the passion that was typical of Lomonosov's fight for the truth."*

Popov ends his "analysis" of Lomonosov's philosophy with the following conclusion: "In this way the spread of European culture became a religious task for Lomonosov, just as the struggle against science was a religious task for his ideological opponents and old-believers of all brands. The men of ancient Russia prized religion above everything else, but Lomonosov elevated science, which had been given such a wide berth by his predecessors, to the level of religion. In so doing he showed himself as a new type of man, and yet remained basically an old, religious type."**

In these groundless theoretical constructions Popov goes so far as to allege that Lomonosov recognised the "evolution of religious consciousness, linking it with the course of the entire scientific understanding of nature", that he was building a new religion by patiently selecting everything that was rational in other religions. Moreover, Popov claims that Lomonosov considered "science the religious sphere of educated people, leaving the Holy Scriptures to people of lower intellectual development",* that is, to the ignorant, uneducated and oppressed masses living in difficult conditions and whose lot, according to Popov, was to swallow what was offered them.

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* *M. V. Lomonosov.* Collection of Articles Edited by V. Sipovsky (Russ. ed.), St. Petersburg, 1911, p. 11.

** Ibid.

Finally, as "proof" of the religious essence of Lomonosov's philosophy all his natural scientific theories were proclaimed to be nothing more than an exposition of Biblical dogmas or premises, writings of the "fathers of the Church", etc.

As was mentioned earlier, the tendency of the champions of religion to put scientific achievements at the service of the church found its fullest expression in the works of V. Solovyov, a philosopher of the idealist type, whom Popov described as the follower of Lomonosov's line in the philosophy of the end of the 19th and the beginning of the 20th century. "Solovyov," he wrote, "demonstrated an original experiment of combining science and religion into a single philosophy." And he went on: "This is more than the outline conceived by Lomonosov. It is a developed and complex system. Historically, however, it falls into line with Lomonosov's experiment. And their destinies are similar. Both experiments enjoyed the support of a very small circle of contemporaries."**

It would have been unnecessary to mention all these efforts by pseudo-scientists to prove the "religious" character of Lomonosov's views if time had swallowed them up without a trace. Unfortunately, such "theories" had influenced some later investigators.

Plekhanov's estimate of Lomonosov's ideological heritage contains many correct and scientifically important thoughts. Yet the individual misconceptions voiced by such an outstanding authority on science as Plekhanov have had a definite influence on some investigators of Lomonosov.

Plekhanov wrote that Lomonosov's discourses "on fasts might not have been to the liking of the clergy, but actually they contained nothing dangerous to the church", and that "here, too, he was little inclined to shake one or another principle". Lomonosov firmly maintained that scientific truth and religion were "two different sisters, daughters of one supreme parent".[*] Without looking deeply into the elements of deism in Lomonosov's philosophy, Plekhanov arrived at the conclusion that this great scientist and materialist roused the indignation of the clergy only by "his free discourses on fasts, or by his mocking hymn to the beard, whereas in the social sense he was always a thorough, and, of course, an absolutely sincere conservative".[**]

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* Ibid., p. 7.

** Ibid., p. 12.

It is impossible to agree with Plekhanov for the simple reason that such ideas do not correspond to reality. Calling Lomonosov, who was a great scientist and thinker and an indefatigable fighter for his country's progress, for the development of science and culture in Russia, a thorough conservative is tantamount to vindicating falsification of his scientific legacy.

Lomonosov did a great deal to break down the general ideological mainstays of religion by his numerous investigations into the most diverse branches of natural science, and particularly by discovering several laws of nature, including the law of the conservation of matter and motion. As we have already said, he consciously and boldly applied the materialist principle in explaining natural phenomena from nature itself without adducing any non-materialist causes or invoking God's help. His new natural scientific theories upheld materialist philosophy. And if he occasionally mentioned God it was a mere tribute to the times, to social custom, a mere appendage to his ideas, not organically connected with his concepts and scientific theories.

It follows logically from the substance of his works that there was virtually no place in nature for God. The universe, he said, was completely filled with a material medium composed of infinitely small and completely solid particles of different size, form, etc., with absolutely no empty space between them. The interaction between bodies and particles could be fully explained on the basis of natural causes, or laws. Lomonosov's atheism was the direct outcome of his views on natural science, and it was not accidental that he cited the following passage from Lactantius: "If it is true that stars are not gods, then neither the Sun nor the Moon can be gods, for they differ from other luminaries not in reason but in size. And if they are not gods, then the heaven which supports them is not god. Similarly if the land which we tread with our feet, and plough and sow for our sustenance is not god, then neither fields nor mountains can be gods, and inasmuch as all this is the truth then the whole universe cannot be considered god.... And so if neither the heaven nor land, which are part of the universe, can be god, then the whole world is not god, whom the stoics call living and all-wise."*

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[*] G. Plekhanov, *Collected Works*, Vol. XXI, 1925, p. 148.

[**] Ibid., p. 147.

In this way the content of Lomonosov's investigations and theoretical generalisations in the most diverse branches of natural science was spearheaded against the fundamental principles and the philosophical foundation of the religious world outlook.

One of the radical methods which scientific philosophy employed in its fight against religion in those days was the defence, development and propagation of the Copernican system. Marx and Engels maintained that Copernicus had inaugurated a new, extremely important stage in the struggle of the scientific view on nature against religious philosophy. Engels wrote: "The revolutionary act by which natural science declared its independence and, as it were, repeated Luther's burning of the Papal Bull was the publication of the immortal work by which Copernicus, though timidly and, so to speak, only from his death-bed, threw down the gauntlet to ecclesiastical authority in the affairs of nature. The emancipation of natural science from theology dates from this, although the fighting out of particular mutual claims has dragged on down to our day and in many minds is still far from completion."** Bruno, Galileo, Kepler, Descartes, Newton and other brilliant minds produced increasing proof in support of the heliocentric system, and, developing it, undermined the foundations of religion.

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* M. V. Lomonosov, *Complete Works*, Vol. 7, p. 159.

** F. Engels, *Dialectics of Nature*, Moscow, 1966, p. 22.

Lomonosov was also among them. Just as convincingly and courageously he upheld the heliocentric system, and enriched and concretised this progressive theory with new investigations and scientific conclusions in astronomy, physics, chemistry and geology. It also does him great credit that he correctly appraised the place and role of both the Copernican system and its eminent supporters in the history of science. "Copernicus," he wrote, "at long last evolved his theory of the solar system, which now bears his name, and excellently demonstrated its application in astronomy. Subsequently Kepler, Newton and other great mathematicians and astronomers perfected this theory to such a degree that it became possible to forecast heavenly phenomena, which was impossible on the basis of the old geocentric system."* Lomonosov viewed the history of astronomy as a process that expanded and deepened our knowledge of the solar system and of the whole of the universe.

Moreover, Lomonosov vigorously popularised the heliocentric system by publishing literature dealing with this theory in Russian translation. The publication of *Talks on the Multiplicity of Worlds* written by the French scientist Bernard Le Bovier de Fontenelle provides an excellent example of Lomonosov's efforts in this direction. The first edition of this book translated by A. Kantemir was printed in 1740. The publication of this work was opposed by the Holy Synod, which approached Elizabeth with an official demand to have it banned "so that henceforth no one will dare write or publish anything either about multiplicity of worlds or anything else that goes against the holy faith and honest morals for fear of being punished as for a grave crime".** Lomonosov disregarded this grim warning and, as Counsellor of the Academy Administration, assumed responsibility for publishing the second edition of this "seditious" book at the Academy printers.

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* M. V. Lomonosov, *Complete Works*, Vol. 4, p. 372.

** Ibid., Vol. 8, p. 1062.

In his own works Lomonosov propagated the ideas of many other upholders of the heliocentric system. He wrote that science knows many "heroes, some of whom have mentally scanned the heavens and forecast what we now have learned from our observations of the stars, while others with the help of clever and skilfully employed instruments discovered more than the former could ever have hoped for".* He was firmly convinced that astronomy would continue to develop in face of the obstacles placed in its way by the clergy, and that as science progressed, scientists using improved instruments would discover new secrets of nature. Bearing in mind, he wrote, that "astronomy needs optical instruments, namely spy-glasses, I had always cherished the hope that these excellent astronomical instruments, the invention of which had crowned Newton ... with glory, might develop not in size as they did up to now, but that they might be improved on the basis of new discoveries in optics and thus become more useful".**

Lomonosov popularised the heliocentric system and the ideas about the multiplicity of worlds in different ways. For example he criticised old, anti-scientific conceptions of the solar system and the superstitions they bred and emphasised that all efforts to find a correct explanation of the motion of heavenly bodies making up the solar system were persecuted. "...And yet, long before the birth of Christ," he wrote, "ancient astronomers such as Nicetas of Syracusae said that the Earth makes one rotation upon its axis in the course of a day. Philolaeus maintained that the Earth makes one revolution around the Sun every year, and a century later Aristarchus of Samos described the solar system in greater detail."*** All these attempts to give a scientific explanation of the solar system were not disseminated. On the contrary, they were buried under all sorts of prejudices. For many centuries "the jaws of idolatrous superstition were tightly clamped over the idea that the Earth moved in space". Consequently, in order to explain celestial phenomena "astronomers had to invent ridiculous cycles and epicycles (circles and side-circles) contradicting the mechanics and geometry of the orbits of planets".*

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* Ibid., Vol. 4, p. 473.

** Ibid., p. 475.

*** Ibid., p. 371.

Lomonosov wrote about the heliocentric system in many of his literary works. His scientifico-literary composition *Letter on the Usefulness of Glass* is particularly interesting. In it he traced the struggle of scientific concepts about the motion of the Sun and the planets against various misconceptions and superstitions and defended science against religion. He gave Copernicus his due for opposing the obsolete anti-scientific ideas of Ptolemy and his followers, and for being the first correctly to explain the movement of the planets of the solar system.

No less resolutely Lomonosov upheld the atheistic concept of the multiplicity of worlds. In the poem *Evening Meditations* he paints a vivid picture of the boundless universe with its innumerable heavenly bodies.

He also offers the conjecture that not only the Earth is inhabited but that there may be living beings and even people on other planets of the solar system and on many heavenly bodies.

At first Lomonosov confined himself to upholding and popularising the Copernican heliocentric system and Fontenelle's idea of the multiplicity of worlds. Later on, however, Lomonosov himself took up astronomy and enriched this science, which has played an important role in philosophy, with new discoveries and generalisations. As a result of his observations of the passage of Venus across the Sun's disc he was the first to arrive at the conclusion that Venus had an atmosphere similar to the one surrounding the Earth. In this respect his conclusion provided another argument substantiating the scientific world outlook. On the basis of this discovery Lomonosov advanced the bold and scientifically interesting hypothesis that there were water vapours, rivers, seas, vegetable and animal organisms and even people on Venus. Needless to say, these conclusions dealt a heavy blow at religion and, as Lomonosov wrote, threw its supporters into confusion.

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* M. V. Lomonosov, *Complete Works*, Vol. 4, p. 371.

With the development of astronomy and other branches of science this original hypothesis became a coherent, well-argumented theory.

It should be noted that Lomonosov speaks of Providence, duality of the truth and so forth only in his published works, whereas there is no mention of God in the preliminary rough drafts that were not intended for publication. This is especially true of the documents describing the passage of Venus across the Sun's disc. All preliminary versions and notes on this subject contain only scientific data and not a word about divine intervention. In his unfinished work *How the Passage of Venus Across the Sun's Disc on May 26, 1761, will Appear to Observers in Various Parts of the World*, written probably at the beginning of 1761, Lomonosov described ways of determining "the most important points on the Earth's surface from where astronomers will be able to observe the passage of Venus across the Sun's disc".* He indicated the exact course of Venus across the Sun's disc, the time when this would take place and all the points on the Earth's surface from where this phenomenon might be observed. He also stressed the practical significance of possessing reliable knowledge about the movement of Venus and other planets.

After May 26, 1761, Lomonosov summed up the results of his careful observations of this phenomenon and wrote a significant scientific thesis *Appearance of Venus on the Sun Observed at the Saint Petersburg Imperial Academy of Sciences on May 26, 1761.* The first part of this work contains a detailed scientific description of his observations and an analysis of the information they yielded. Here, too, there is no mention of God. The second part *Addenda* implies that the Copernican heliocentric system does not contradict the Scriptures and that religion should not interfere in astronomical investigations or place obstacles in their way. Lomonosov ridicules theologians "who think that one can learn astronomy or chemistry by studying the Psalter".

He condemned the fanaticism of the Catholic Church and its brutal persecution of scientists and thinkers who proved the absurdity of many canons and rites and exposed the flagrant contradictions in the fantastic inventions and legends of the Bible and the Gospel. Pope Clement VIII and the dignitaries of the Catholic Church took a savage revenge on the brilliant thinker Giordano Bruno, who rejected the Christian dogma of the Trinity, the Virgin birth, Christ and other legends. Here are some of the questions which the Inquisition asked Bruno and which caused the church particular apprehension and aroused its undisguised animosity: "Did you censure the Catholic monks and especially for the fact that they have incomes?"; "Did you say that the mode of life of the monks does not conform to the mode of life of the apostles?"; "Did you criticise the activity of our Holy Mother the Church, which is guiding Christian people along the road designated by God, and meting out retribution to those who deviate from the Catholic faith?"; "What do you think about the ban on food imposed by the Church, about the observance of fasts, or abstinence from meat on fixed days?"*

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* Ibid., Vol. 4, p. 435.

The Orthodox Church in Russia kept abreast of the Catholic Church in persecuting progressive scientists and thinkers. Lomonosov's personal experience convinced him of this. The direct pretext for the campaign which the leaders of the Orthodox Church and its organ the Holy Synod launched against him was his poem *Hymn to the Beard*. Here Lomonosov ridiculed, among other things, the religious custom maintained by the Orthodox clergy of wearing beards and long hair. But that did not exhaust the substance of the poem. Lomonosov flayed the priests for illegally adjusting their secular affairs using religion as a screen. The beard served to hide ignorance, immoral conduct and so forth.

The *Hymn to the Beard* was not written by chance; it was Lomonosov's deliberate rejoiner to the increasing interference of the church leaders and the Holy Synod in the affairs of universities and the Academy of Sciences. Eloquent evidence of this interference was the ban imposed on the publication of Pope's *Essay on Man*, which had been translated into the Russian under Lomonosov's supervision by Professor N. Popovsky of Moscow University. The Holy Synod issued a statement concerning this work, which said in part: "The publisher of this book quotes nothing from Holy Scripture nor from what has been accepted by our Orthodox Church, but sets down his own concepts of nature supplementing them with the Copernican system and views about the multiplicity of worlds all of which completely contradict the Holy Scripture."*

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* V. Spampanato, *Vita di Giordano Bruno con documenti editi e inediti,* Messina, 1921, pp. 722-24.

The persecution to which Lomonosov was subjected for his *Hymn to the Beard* was not confined to demands by church leaders to inflict strict punishment on him, but also took the form of anonymous letters sent to Lomonosov himself and to Müller and Trediakovsky and whose author in all probability was Dmitry Sechenov, a member of the Synod and the Bishop of Ryazan. In his letter to Lomonosov the anonymous author quite correctly observes that Lomonosov strikes at religion as a whole not only in this poem but in other works as well. The letter says that Lomonosov has not limited himself to desecrating the beards of priests, but "wanted to make a laughing stock of our religion. Take, for example, his indecent manner of describing the sacrament of christening, a rite by means of which we live in expectation of future bliss. Or what do his words 'screen of false opinions' imply? Perhaps he has in mind the teaching offered us in the Holy Scripture and the dogmas of our Church, which has been handed down to us by its great teachers through their successors who cannot and must not impart any other views except those that they themselves have learned from the great teachers? How can a person call these views false, unless he has himself foresaken conscience, honour and religion"?**

The same "holy father" wrote a letter to Trediakovsky and, playing on the latter's hostile feelings towards the great scientist, solicited his assistance in organising a campaign against Lomonosov.

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* M. V. Lomonosov, *Complete Works*, Vol. 8, p. 1062.

** *Lomonosovsky Sbornik,* St. Petersburg, 1911, pp. 92-93.

The church leaders asked Elizabeth to institute proceedings against Lomonosov for sacrilegious conduct and it was only thanks to the intervention of I. Shuvalov and some other statesmen that these plans were not realised. Undaunted by the threats of the church hierarchy, Lomonosov replied with an epigram and another poem called *Hymn to the Beard for the Trial*, in which he ridiculed the priests' efforts to pass judgement on him.

At the time Lomonosov's polemics with the clergy was a major link in the chain of conflicts between men of science and culture, on the one hand, and apologists of religion, on the other. There are sufficient grounds for asserting that in the concrete historical situation in Russia of the mid-18th century, Lomonosov's opposition to the priests was a manifestation of his atheism.

In numerous works he criticised Christian dogmas and propositions which contradicted scientific data and conclusions. On the basis of accumulated knowledge and repeated observations of geological processes he deduced that the Earth was incomparably older than was claimed by the Bible and other religious books, and proved that Biblical legends were completely fictitious from the scientific point of view. He wrote: "Those who do not agree that the evolution of natural objects and phenomena requires many more centuries than computed in the accepted ecclesiastical calendar, should bear in mind: (1) that this calendar is not a dogma fixed and promulgated by councils, but only a means of comparing ancient times with more recent ones and by chronologically listing the deeds of various sovereigns to describe historical events and so forth; (2) that despite the fact that in estimating the date of the creation of the world our Eastern Christian religion differs from the .Western Church by more than 15 centuries there have been no conflicts between them on these grounds; (3) and no conflicts can arise because even today the most skilled teachers of Hebrew cannot clearly see their way through the confused and doubtful dates and other places in the Hebrew Old Testament. (4) And this is not the least important explanation of the fact that all Christian people begin their chronology from the birth of Christ and disregard the ancient times because their knowledge about them is dubious. (5) Moreover, our Christian chronologies do not see eye to eye on this issue. . . ."*

Lomonosov emphasised the absurdity of religious assertions that the Earth was only a few thousand years old, and pointed out that such "data" could not be applied in science, which required information gleaned from nature itself. In pursuance of his line of completely separating science from religion he studied the general laws of nature and natural phenomena, not caring whether his investigations contradicted religious dogmas or not. He repeatedly stressed that a real scientist must discard all prejudices and outdated views, including religious myths, and employ only the scientific materialist method of study to understand natural phenomena. This method, he maintained, should be used also to determine the origin of our planet, its age and so forth, and that in this case, as in any other scientific problem it was futile to rely on the Gospel, the Bible, or the Psalter. Those seeking an answer to these questions by advancing various interpretations of religious legends, parables or apothegms were at liberty to continue their fruitless work, he maintained, but without hindering scientific study of nature. "Let other people," he wrote, "study all church, temporal, Christian or heathen chronicles and turn to higher mathematics for help; let them determine the year, the day and the moment of creation; let them chart in the sky the position of the Sun, the Moon and the planets and ascertain how far they were from each other when they first began to shine. . . . I agree with everything and argue against nothing. But at the same time I also want to find out the same things for myself in my chronicle."** By "my chronicle" Lomonosov meant nature itself and its general laws. There is no direct reference to the age of the Earth in his works. Yet his thoughts about climatic changes resulting from the change in the inclination of the Earth's axis with respect to the Sun, which lasted over many hundreds of thousands of years permit us to conclude that he believed that it took an extremely long time for the Earth to evolve from its initial molten stage to its present appearance.

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* M. V. Lomonosov, *Complete Works*, Vol. 5, p. 617.

** Ibid., p. 618.

He courageously exposed the Biblical myth about the Flood as a result of which, it was alleged, the fossils of vegetables and animals had been carried from the tropical to the northern regions.

In those days even Johann Friedrich Henckel, Georg Wolfgang Krafft, Karl Nikolaus Lang and other prominent scientists used Biblical legends to explain the presence of sea shells on mountain tops. Lomonosov opposed this Biblical view and endeavoured to explain all natural phenomena scientifically. In his opinion one of the reasons for the presence of shells on mountain tops might have been elevation of the sea or ocean bottom. Step by step, on the basis of the laws of nature, he shows the weakness of the Flood theory. First, shells are heavier than water. Second, according to the Biblical legend, the Flood resulted from torrential rains, but, as is known, gravity makes water flow from the elevated places down to the lowlands and could not have raised the shells to the mountain tops. Further, it is impossible to believe that testudinal animals, which move very slowly, could have reached the tops of mountains during the 150 days that water covered the face of the Earth, as the legend relates. Finally, "it contradicts the laws of nature that they should have climbed mountains in search of unfamiliar habitation and food, leaving their natural environment behind".* It is common knowledge that the Orthodox and the Catholic priests zealously uphold the "sanctity" and inviolability of religious rites and holidays, viewing them as a firm mainstay of Christianity. That is why they have always taken vigorous action, and are doing so today, against anyone who may be sceptical or directly opposed to one or another rite or holiday. Lomonosov was well aware of all this and yet frankly criticised some of them. Contrary to the assertions of theologians he showed that religious holidays were instituted by ordinary mortals and that it was possible to make radical changes in them. In the northern areas with cold climate and long winters religious holidays had been instituted without regard to local conditions. This was a mistake. Addressing those who had fixed the dates for religious holidays, Lomonosov asks: "Did you think about us when you established the Great Fast for this time? I believe that in your holiness, meekness and sincerity you will volunteer a favourable answer and will not act as the Archpriest Yakov, who showered obscenities on us in church and who struck shipmaster Yankov in the chest on Easter Sunday for refusing to kiss his hand at the cross. Your reply will be: 'We were living in Greece and in the Promised Land when we appointed holy days and fasts. At the time we decreed that Quadragesima be observed when our land opens its rich bosom under the brilliant sunshine, young vegetation is filled with life-giving juices and the air is renewed with aromatic smells; when early fruits ripen and feed, refresh and cure us of ailments; when our songs in praise of God are accompanied by the murmuring of springs, the rustle of foliage and the songs of sweet-voiced birds. As regards your septentrional regions, we thought that there was no Christianity there and never would be, and also that no person could live there because of the great cold. Do not blame us. For how could we have prescribed that you should eat dates and figs and drink a cup of wholesome grape wine if you lack all these things. Act as thinking people and transfer your fast to a more appropriate time, or partake in moderation of nutritious foods.'"* This approach to the principal festival of the church in no way sustains the allegation that Lomonosov was a "true son" of the Orthodox Church.

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* M. V. Lomonosov, *Complete Works*, Vol. 5, p. 579.

Lomonosov also protested against the barbarous rite of baptising infants in cold water. He showed his concern for the preservation and the numerical growth of the Russian people by demanding that it be banned. "... There is no need to teach physics to ignorant priests," he wrote, "it is enough to pass a law forbidding baptism in cold water." As regards "those stubborn priests," he continued, "who continue to baptise infants in cold water, they are, in my opinion, executioners, for it is in their selfish interests that birth and christening should soon after be followed by a funeral. There are a great many unfortunate parents who have had 10 or 15 children, of whom not a single one has remained alive."[*]

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* Ibid., Vol. 6, p. 395.

Lomonosov did not take things at their face value. He endeavoured personally to verify all theories and conjectures advanced by other scientists and rejected those whose veracity could not be proved. As regards religious miracles, he held that science should leave them well alone for they contained nothing more than fantastic fabrications, although there were "Catholic theologians who draw on physics in order to explain the miracles performed by God, and the most terrifying sacrements of Christianity".[**] In those days there were many oracles, "predictors" of the end of the world who took advantage of the ignorance of the oppressed and illiterate and disseminated monstrous lies, implanting fear, confusion and frustration in their minds. The priests speculated on solar and lunar eclipses, appearance of comets, northern lights and other "mysterious" phenomena.

It was the task of all scientists, according to Lomonosov, to fight persistently against superstition, sorcery and mysticism. He himself gave a fine example of how to popularise scientific knowledge. In the *Appearance of Venus on the Sun* he offsets superstitious interpretations of the eclipse by presenting a scientific explanation of this phenomenon. He wrote that by correctly explaining why Venus passed across the disc of the Sun, scientists would be able "to remove from the minds of the people all unfounded doubts and fears, sometimes leading to unrest". "Many credulous people," he continued, "listen with terror to the prophesies made in connection with heavenly phenomena by wandering beggar-women, who have never heard of astronomy in their long lives, and most probably have never glanced skyward, being prevented from doing so by their habitual stoop. The stupidity of such ignorant soothsayers and trustful listeners elicits nothing more than derision and contempt. With regard to those whose uneasiness is aroused by these frightening predictions, their uneasiness is the punishment they deserve for their witlessness."[*]

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[*] M. V. Lomonosov, *Complete Works*, Vol. 6, p. 391.

[**] Ibid., Vol. 5, pp. 618-19.

Investigations of the origin of comets, northern lights and other phenomena, which at the time seemed mysterious, helped eradicate all sorts of superstitions. Lomonosov considered that comets' tails contained electricity and in this respect had much in common with the northern lights. He wrote that inasmuch as "the tails of comets are not vapours emitted by the latter but only the motion of aether occasioned by electrical forces, the fear which the appearance of comets evokes in many people who believe that they cause great floods on the Earth is absolutely unjustified".[**] He was also greatly disturbed by the fact that the low level of medical science and the acute shortage of doctors prevented the adoption of effective measures to combat numerous diseases and led to high mortality of the population and the spread of quackery and other superstitions in Russia. "...Ordinary illiterate men and women," he wrote with indignation and pain, "treat people frequently by combining administration of those natural medicines with which they are familiar with sorcery and incantation, and in so doing not only do not add potency to their medicines, but strengthen superstitious beliefs in people and by their fearsome appearance implant terror in the sick, thus aggravating their illness and bringing them closer to death."[***] He maintained that to fight successfully against different diseases and to eradicate witchcraft, exorcism and other superstitions it was imperative to promote medical science, to disseminate its achievements among the people and to train a large number of Russian medical workers.

Lomonosov wrathfully criticised the Orthodox priests for their outrageous behaviour and greed, for fostering ignorance among the population and for brutally persecuting the heterodox. "The priests," he wrote, "are the biggest drunkards at all carousels in towns and villages. Not content with making the rounds of public houses after dinner, they even engage in brawls in which blood is shed." In his opinion the immoral conduct of the priests was due to their lack of education, intelligence and culture. "In many places, " he noted, "the priests are no more literate than a local farm labourer or a cow maid."*

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[*] Ibid., Vol. 4, p. 370.

[**] Ibid., Vol. 3, p. 97.

[***] Ibid., Vol. 6, p. 396.

Lomonosov occupied an important place in the history of atheism in 18th-century Russia. The atheistic trend in his works was a source of ideological principles for revolutionary-minded nobility and revolutionary democrats.

The best atheistic traditions in Lomonosov's works have retained their significance to the present day. In 1922, Lenin wrote that in their ideological struggle against religion Marxists should draw on the atheistic works of the 18th-century French materialists. Lomonosov in his atheism did not rise to the level of the French materialists, but his works contain many propositions and scientific generalisations which can be usefully employed against religious ideology.

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* M. V. Lomonosov, *Complete Works*, Vol. 6, p. 408.

CONCLUSION

Mikhail Lomonosov occupies a prominent place in the history of advanced philosophical thought. His discoveries in various branches of knowledge about nature and original natural scientific and philosophical generalisations greatly stimulated the development of materialism and atheism. He boldly rejected outdated scientific and philosophical theories and ideas and brought new, unsolved problems to the fore. He swept aside obsolete traditions, rules and dogmas that fettered scientific thinking. It was not in his nature to follow blindly the scientific authorities of the past. Although he had great respect for the ancient scientists and philosophers he was categorically against considering their views infallible and requiring neither verification nor further development.

He had high praise for such scientists as Galileo, Kepler, Descartes and Newton who drew on the scientific achievements of the past but were not afraid to blaze new trails for science.

Lomonosov's philosophy evolved and developed in the difficult, contradictory social conditions that prevailed in Russia in the first half and the beginning of the latter half of the 18th century, in bitter struggle against bigotry, backwardness and obsolete concepts and traditions, and against the enemies of new progressive trends in science. Many of his contemporaries, even those who were playing a progressive role in scientific development, did not comprehend a great many of his ideas, theories and plans. And they certainly could not foresee the marvellous future of the work he was doing. Literally only a few of the most outstanding scientists of the time perceived that he had reached the apex of mid-18th-century scientific thinking in his investigations, and were able to visualise the prospects that his creative genius had revealed to science. The first among these men was Leonhard Euler, a brilliant 18th-century scientist and a contemporary of Lomonosov. But even the most perceptive minds of the day could not have foretold that Lomonosov's ideas would become the centre of a bitter controversy which has continued for almost two centuries now, nor could they imagine the triumph of these ideas which were sustained by the unprecedented achievements of 20th-century science.

Lomonosov concentrated on emancipating science, including philosophy, from the influence of idealism and religion. Thus, it was not accidental that reactionary-minded Russian and West-European scientists regarded Lomonosov as one of their most dangerous enemies. They opposed all his progressive scientific, philosophical and social and political ideas. The first opponents and falsificators of his scientific and philosophical views appeared during his lifetime. In the St. Petersburg Academy Schumacher and his followers slighted him in every way and organised opposition to his new discoveries and generalisations at Academy meetings and in periodical publications. In a letter to I. Shuvalov, Lomonosov angrily exposed Schumacher as an enemy of real science and, consequently, his, Lomonosov's enemy, calling him "an insidious and cunning inciter of quarrels and enmity".* Lomonosov was also attacked by Taubert, who supported Schumacher. In the same letter Lomonosov pointed out that Schumacher's and Taubert's inherent "envy and hatred for scientists is the result of the fact that they are endeavouring to win authority not by serving science, but by appropriating the works of others and, particularly, by slighting professors and inciting them against each other so as to use their disagreements to serve their own ends".**

Some West-European scientists also opposed the new scientific theories elaborated by Lomonosov.

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* M. V. Lomonosov, *Complete Works*, Vol. 10, p. 495.

** Ibid., p. 495.

After Lomonosov's death the reactionaries took up the line set by A. Shuvalov. This courtier wrote a biography of Lomonosov in which he painted an absolutely false picture of the great champion of progress, and claimed that Lomonosov was a faithful courtier who enjoyed the "gentle solicitude" of the nobility. "All our sovereigns," wrote Shuvalov, "patronised and encouraged this great man who was Russia's first scientist. Empress Elizabeth made him Professor of Chemistry at the St. Petersburg Imperial Academy of Sciences and showered benefits on him. The presently reigning Empress was even more generous, for she treated him with a familiarity whose features were known only in the age of Augustus, but which never made the scientist feel humiliated.

"Finally, surrounded with glory and the wonder of his compatriots and loved by monarchs, Mr. Lomonosov passed away several years ago having reached the age of almost fifty-five."*

For many decades Lomonosov's best ideas were adulterated, his services to science were hushed up and various obstacles were set up to prevent the publication of his works. All this, of course, was a loss to science and gave rise to the false opinion that Lomonosov was forgotten and did not influence the subsequent development of scientific thinking, and that he was "rediscovered" only at the beginning of the 20th century by the Russian scientist B. Menshutkin.

This, too, is untrue. Lomonosov's works were held in high esteem by many eminent scientists and scholars. N. Popovsky, A. Barsov, Y. Kozelsky, P. Baturin, A. Radishchev and other progressive Russian cultural leaders of the second half of the 18th century were directly influenced by Lomonosov's works, and defended and creatively developed his best ideas. The same is true of the first half of the 19th century. Suffice it to mention such names as V. Severgin, I. Dvigubsky, D. Perevoshchikov, A. Lovetsky, M. Spassky, M. Pavlov, G. Shchurovsky, and M. Maximovich. Progressive Russian scientists vigorously protested against the attempts of some scientists and philosophers to falsify Lomonosov's works, to make people forget them and to ascribe his merits to West-European scientists. Perevoshchikov, for example, voicing his enthusiasm for Lomonosov's theory of heat, wrote in 1824: "Does not Lomonosov's proposition have all the merits of a real theory? And if it does, then why are we, Russians, forgetful of it? Why do we take for granted and repeat in our text-books the words of foreign scientists, who in their ignorance of Lomonosov's reasoning in one voice assert that it was Rumford who first suggested that heat originated from the internal motion of substances?"* Perevoshchikov's assertions were borne out by the following fact. Lomonosov had built firm scientific foundations for his theory of heat as early as the middle of the 18th century, and published his scientific conclusions in the form of articles written in Latin publications issued by the St. Petersburg Academy of Sciences. His works were read by many West-European scientists. A. Kunik wrote in this connection: "The first series of academic notes which were called commentaries at the time, were very warmly received by European scientists and laid the cornerstone of the scientific glory of the Academy. Some time later the Academy itself considered it necessary to publish a second edition of this series, the first eight volumes of which were reprinted in Bologna in 1740-52. The second series began coming out in 1750 under the title *New Commentaries* and, in spite of unsatisfactory international connections and trade in books, appeared in various European countries and attracted the attention of their scientists, as was testified by the reviews that were printed in the periodical literature of those days."** Although Lomonosov's works were published in *New Commentaries*, not a word was said about him by many renowned 19th-century Western scientists. The German scientist Rudolf Clausius ((1822-88) in his *Mechanical Theory of Heat* repeated Lomonosov's propositions and conclusions without saying whose they were. "Previously," Clausius wrote nearly 100 years after the publication of Lomonosov's works, "it was almost universally believed that heat was a special substance which to one or another degree was present in all bodies, and determined their temperature. It was assumed that all bodies emitted this substance which thereupon flew through space and even mass-filled media with enormous speed and thus originated radiant heat. Lately, however, the view has come to the fore that heat is some sort of motion. Moreover, the heat which is present in bodies and determines their temperature is being viewed as a specific type of motion of ponderable atoms, which can also be joined by the aether contained in bodies. Radiant heat is regarded as the oscillatory motion of aether."*

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* *Lomonosov.* Collection of Articles and Documents, Vol. II, Moscow, 1946, p. 48.

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* *Athenaeum*, March, 1829, No. 5, p. 488.

** A. Kunik, *Collection of Documents for Compiling the History of the Imperial Academy of Sciences in the 18th Century* (Russ. ed.), Part II, St. Petersburg, 1865, p. 502.

Let us turn to Lomonosov's last version of *Meditations on the Origin of Heat and Cold* written in 1749 and published in Latin in *New Commentaries*. It is out of the question that this work, which disproved the unscientific hypothesis about calorific matter and explained the origin of heat, had not been read by European scientists. After thoroughly studying the problem of heat Lomonosov arrived at the following conclusion: "the presence of heat in bodies cannot be ascribed to a condensation of some sort of fine heat-producing matter. Heat is caused by the internal rotational motion of connected matter of a heated body. Thus, we assert that this motion and heat are inherent also in the finest matter of aether, which fills up all the space between sensitive bodies, and that this matter can communicate the calorific motion received from the Sun to the Earth and other planets and heat them, and that it is the medium through which separate bodies impart heat to each other without the assistance of any perceptible substance."**

The tendency to ignore Lomonosov's discoveries and theoretical generalisations became more pronounced in the latter half of the 19th and the beginning of the 20th century, although it had become easier to study his works, particularly after many of them had been published on the occasion of the centennial of his death. At the close of the 19th century the Russian Academy of Sciences started publishing a collection of his works. Nevertheless, Western historians of the natural sciences continued to ignore and, frequently, even denied his services to science. This tendency was mirrored even in the best works of the Western bourgeois historians of natural science. As regards the "investigations" of reactionary historians, they were written in a spirit of discrimination against the achievements of Russian science and many eminent Russian scientists, including M. Lomonosov, N. Lobachevsky, I. Sechenov and D. Mendeleyev. Characteristic in this respect is the standpoint of the German historian of natural sciences Friedrich Dannemann. His four-volume work on the history of natural sciences fails to mention Lomonosov's scientific ideas in the fields of physics, chemistry, geology or astronomy, and not a word is said about his materialist philosophical concepts.

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* R. Clausius, *Die mechanische Wärmetheorie*, Bd. I, Braunschweig, 1887, S. 22.

** M. V. Lomonosov, *Complete Works*, Vol. 2, pp. 53-55.

It was not by accident that after reading Dannemann's book *How Did Our Picture of the World Arise,* Lenin wrote: "The author carelessly, pompously, vulgarly, in feuilleton style outlines philosophical questions, banal."*

In the introduction to his work *History of Natural Science. The Development and Interaction of Natural Sciences,* Dannemann himself pointed out that it was important to study the history of natural sciences in different countries and that it was imperative to "review what has been accomplished already and by drawing on the storehouse of science find fresh hope of discovering the connections and underlying pattern of natural phenomena."** He underlined that it was impossible to write a history of science in Germany in isolation from the general development of knowledge.

Yet he falsified the history of natural sciences by clearly exaggerating the role of many mediocre German and other

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* V. I. Lenin, *Collected Works,* Vol. 38, p. 333.

** F. Dannemann, *Die Naturwissenschaften in ihrer Entwicklung und in ihrem Zusammenhange,* II. Auflage, Bd. I, S. VI.

Western scientists and impermissibly ignoring the achievements of Russian scientists. He quoted from the multi-volume *Classics of Precise Sciences* published under the editorship of Wilhelm Ostwald, although it was universally known that it blatantly upheld the west-orientated point of view. Even Lomonosov's great contribution to Russian and world science was hushed up in this work numbering 195 volumes. Moreover, Ostwald utterly falsified facts by alleging that Lomonosov did nothing more than propagate the achievements of Western scientists in Russia.

The importance of Lomonosov's scientific, linguistic and literary works was also deliberately underestimated by many aristocratic and bourgeois historians in tsarist Russia. Moreover, they crudely distorted his progressive philosophical views, considering them a threat to tsarism's reactionary ideology.

I. Kireyevsky and other Slavophiles claimed that Russian literature and philosophical thought were neither independent nor original. "...We are still influenced by the French and the Germans," Kireyevsky wrote. "Our literature is divorced from the life of our people."* He believed that the same applied to philosophy and alleged that Russia possessed no original philosophy of her own in the 18th century or even in the first 30 years of the 19th. "Our philosophy," he wrote, "is yet to be formed and, as I have said, not by one man. It has to rise for all to see with the encouragement of a general consensus."** He had the audacity to assert this at a time when apart from Lomonosov Russia already had many brilliant thinkers, including the group of enlighteners of the second half of the 18th century, Radishchev, and the aristocratic revolutionary Decembrists. Kireyevsky was an idealist who wanted to create a philosophy that would become the theoretical foundation of Christianity and autocracy, and promptly rejected any other philosophy.

An analogous stand in this question was taken up by Kavelin, Katkov and Yurkevich, idealist philosophers from the Russian liberal bourgeoisie. In their admiration for West-European idealist philosophy they considered that Russian philosophy was imitative in character and at best nothing more than a shadow of the Western idealist theories. Kavelin, for example, alleged that there was not and could not be any successiveness in the development of philosophical theories in Russia.

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* I. Kireyevsky, *Complete Works* (Russ. ed.), Vol. II, St. Petersburg, 1861, p. 203.

** Ibid., p. 332.

At the close of the 19th and the beginning of the 20th century Russian aristocratic and bourgeois historians continued to develop this conception. The idealist A. Vvedensky in his *Destiny of Philosophy in Russia* endeavoured to show the borrowed character of Russian 18th-19th century philosophy. He was not interested in anything new that had been introduced into philosophical science by Russian philosophers but wanted to know "when this borrowing took place, in what conditions it was accomplished and developed and precisely what has Russian philosophy managed to achieve in these conditions."* He regarded the years from the middle of the 18th to the beginning of the 19th century as a period of simple, apologetic assimilation and propagation of Western philosophical theories. "We had to begin," he wrote, "directly with absorbing the already framed West-European philosophy. It is natural, therefore, that the first period of the existence of philosophy in Russia, which lasted exactly 50 years, passed almost without leaving a trace; it only stimulated interest in philosophy, stirred up our minds and prepared us for studying it more profoundly."**

Just as false were the methodological positions of Russian historians of philosophy Bobrov, Gershenson, Berdyayev, Bulgakov and other idealists. This accounts for their extremely reactionary conclusions regarding the causes, ideological beginnings and the role played by Russian philosophy in the history of social thought in Russia and Europe. These apologists of the landowner-bourgeois reactionaries did not have even a hint of national pride for the scientific accomplishments of their brilliant countrymen.

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* *Philosophical Essays*, Prague, 1924, p. 8.

** Ibid., p. 9.

For them every Russian philosopher was a reteller of the ideas of Leibniz, Wolff, Berkeley, Hume and other Western philosophers of their type.

As we have already said, one of the most widespread methods of falsifying Lomonosov's philosophy was to assert that he transferred to Russian soil the idealistic philosophy of Leibniz and Wolff. Russian idealists directly claimed that Lomonosov and his followers were imitators of the monadology of these two German philosophers.

Contemporary bourgeois falsifiers of the history of Russian philosophy are continuing the same insincere traditions of their predecessors.

We have already said that there were elements of deism in Lomonosov's works. He wanted to emancipate science from the influence of religion and believed at the same time that religion and science should delimit their spheres of action and co-exist peacefully without interfering in each other's affairs. "A mathematician," he used to say, "who wants to measure the will of God with a pair of compasses is foolish. And so is the theologian who thinks that he can learn astronomy or chemistry by studying the Psalter."*

But even if he did occasionally mention God in his works, it in no way disproves the fact that he was an active and conscious materialist. An analysis of his numerous works shows beyond any doubt that he did not turn to religious dogmas to explain natural phenomena, but sought to understand them from nature itself, from its general laws.

Present-day apologists of religion and obscurantism persist in speculating on individual statements of the great scientists of the past. An example of such falsification of the true course of the scientific development, including philosophy, is the work of the regular priest Ferdinand Lelott *Solution of the Problem of Life*, published in 1959. In this "research paper", which claims to be scientific, the author bends over backwards to prove that the priests have always displayed concern for scientific progress, and that they themselves have solved many scientific problems. Without citing proof Lelott claims that the ministers are not only popularising the fruits of human science but are also actively participating in making scientific discoveries. This assertion is absolutely divorced from the historical truth.

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* M. V. Lomonosov, *Complete Works*, Vol. 4, p. 375.

To give a scientific background to his fabrications, Lelott plunges into various historical digressions distorting the works and activity of the true champions of science. He alleges that the church has many sons among the secular scientists, which proves that religion is no obstacle to scientific work. True enough there were scientists who did not break with religion and yet successfully continued their scientific activities. But the only thing this proves is that as scientists they were not sons of the church. On the contrary, their scientific studies were undermining the principles of religion. And still even they were not the ones whom Lelott had in mind. Most of all he was concerned with the proponents of scientific progress, including the development of materialist philosophy. His list of "true sons of the church" includes the great Russian scientists M. Lomonosov, N. Pirogov, A. Popov and I. Pavlov. As regards Lomonosov, Lelott acknowledges that he was a brilliant scientist and one of the founders of modern chemistry, physical chemistry and the science of atmospheric electricity. He then turns the facts upside down by calling Lomonosov a "great religious poet".

We repeat that Lomonosov's creative activity in all branches of knowledge and culture was atheistic in character in spite of certain historical limitations and the elements of deism it contained. The dignitaries of the Russian Orthodox Church could not but consider it alien to religion. The following episode illustrates this point. In 1832, a monument to Lomonosov sculptured by I. Martos was unveiled in Archangel. Among the guests at the ceremony there was a group of ministers of religion. In a special message Metropolitan Filaret severely censured these priests, thus making it clear that such a "true son of the church" deserved neither a monument nor the commiseration of the church.

V. Zenkovsky, a contemporary reactionary historian of Russian philosophy, speaks up in the same spirit as Lelott. In his *History of Russian Philosophy* Zenkovsky endeavours to prove that Lomonosov adhered to a "trend possessing a religious-philosophical character, a trend which follows the line of secularisation, that is, without breaking with Christianity it becomes more and more separated from the church".* Nonetheless, Zenkovsky has to admit that Lomonosov shook religious principles rather than strengthened them.

Falsifiers of Lomonosov's works today more and more often fall back on the questionable ideas of bourgeois-landowner historians. Their writings rest on the conclusions made by Ivanov-Razumnik, Gershenson, Berdyayev and their like. The former, a liberal historian of literature and publicist, crudely distorted the ideological heritage of progressive Russian scientists and writers, including Lomonosov. Ivanov-Razumnik asserted in his *History of Russian Social Thought* that "up to the middle of the 18th century there were no intellectuals in Russia", and, therefore, "there was also no active continuity in the struggle for definite ideas and against a definite system".** Without a second thought he nullifies the activity of T. Prokopovich, A. Kantemir, V. Tatishchev and I. Pososhkov, Lomonosov's predecessors and outstanding enlighteners of the period of Peter the Great's reforms. Proceeding from this conception Ivanov-Razumnik also regards Lomonosov's creative activity not as a logical stage in the development of advanced science and culture in Russia, but as something foreign to the nature of Russian society, as futile pseudo-classicism. Although he calls Lomonosov a "man of great intellect" he is not deterred from asserting that Lomonosov's artistic works are "full of lifeless material", that "there was not a single Russian 18th-century pseudo-classic who succeeded in breathing life into Lomonosov's lifeless forms", and that "life in Lomonosov's works makes its way to the fore only in a few moving passages but is immediately stifled by loud outcries".***

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* V. Zenkovsky, *History of Russian Philosophy* (Russ. ed.), Vol. 1, Paris, 1948, p. 91.

** R. Ivanov-Razumnik, *History of Russian Social Thought* (Russ. ed.), Vol. 1, St. Petersburg, 1908, p. 23.

*** Ibid.

Many participants of the Russian liberation movement gave the lie to such undisguisedly biased and false assessments of Lomonosov's heritage and the role he had played in the history of Russian culture. The real heirs of everything progressive born of Russian science and culture warmly defended Lomonosov against undeserved slander by his enemies. V. Belinsky, the great Russian critic and philosopher, wrote: "Our literature begins with Lomonosov; he is its father and mentor, he is its Peter the Great."*

Those works of Lomonosov's that during his lifetime had been sent to all European academies elicited great interest among German, Italian, French, Swedish and English scientists. Some European scientists entered into polemics with him on problems of atomistics, physics, mathematics and astronomy, while others gave him wholehearted support. In appreciation of his services to science he was elected a member of the Swedish and Bologna Academies of Sciences. The Swedish Academy of Sciences wrote the following official letter in this connection: "Mr. Mikhail Lomonosov, Counsellor and Professor of the St. Petersburg Academy of Sciences has long been well known in scientific circles and has made a glorious name for himself by his services to science. At present, too, he is correcting and elucidating sciences, particularly physics, so conscientiously and successfully that the Royal Swedish Academy of Sciences, to its honour and benefit, has decided to establish the closest possible ties with this eminent man. For this purpose the Royal Swedish Academy of Sciences has elected the great Mr. Lomonosov to its membership and in this letter extends its friendly greetings to him as to a member of the Swedish Academy, trusting he will consider it his own Academy and assist it as such. On behalf of the Royal Swedish Academy of Sciences the above is attested with this seal on May the 7th, 1760.

"Peter Wergentin, Secretary of the Royal Swedish Academy of Sciences."**

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* V. Belinsky, *Collected Works* (Russ. ed.), Vol. 1, Moscow, 1948, p. 29.

** M. V. Lomonosov, *Selected Philosophical Works* (Russ. ed.), State Publishing House of Political Literature, 1950, p. 712.

Le Clerc, a French scientist and doctor of medicine, who came to Russia right after Lomonosov's death made a speech at the Academy meeting at which he said: "A man has passed away whose name will constitute a whole epoch in the annals of human thought, a profound and brilliant genius who embraced and suddenly illuminated many branches of knowledge. A lofty poet has passed away who in moments of his truly great inspiration resembled a bird, which, soaring above the clouds fixes its gaze on the Sun without being blinded by its radiance.... Society used his knowledge, and your chronicles will make use of his glory. He will be esteemed wherever there are educated people."*

Many scientists in Russia who had analysed his scientific heritage acknowledged his great service in posing and solving new problems and blazing new paths in science. Academician V. Severgin, an eminent Russian scientist of the 18th and the beginning of the 19th century, made the following comment about Lomonosov: "To bring new light into the sciences, to discover ways of bringing them to the heights of perfection and to establish sure roads leading to this end are deeds that can be accomplished only by men endowed with rare and great talents."**

Two centuries separate us from the time when Lomonosov carried on his versatile activity. In this period many would-be commentators have endeavoured to show up his outstanding works in a false light. Falsifiers came and went, but Lomonosov's wonderful scientific ideas continued to live in the minds of the advanced Russian and foreign scientists.

Lomonosov's ideological heritage received full recognition and an all-round scientific appraisal only after Soviet rule was established in Russia. His discoveries and ideas were substantiated in practice and in the course of development of scientific thinking and now hold a firm place among the most valuable possessions of world science and culture. His investigations and theoretical generalisations in the natural sciences, philosophy, literature and linguistics are the pride and honour of Russian science. Lomonosov's name and his great services to sciences and education are recognised by progressive scientists and men of culture throughout the world. Try as they might the would-be historians of philosophy from the camp of neo-Thomists, Christian existentialists and neo-positivists cannot belittle his role in the history of social thought or adapt his works in the spirit of idealism.

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* P. Pekarsky, *History of the Imperial Academy of Sciences in St. Petersburg* (Russ. ed.), Vol. II, St. Petersburg, 1873, p. 878.

** M. Sukhomlinov, *History of the Russian Academy* (Russ. ed.), Issue 4, St. Petersburg, 1878, p. 158.

Lomonosov has already lived long in the minds of all who believe sincerely in science and education as a brilliant natural scientist, materialist philosopher, a patriot and a great humanist and enlightener of the Russia of the 18th century.

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